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LABOUR UNREST.

UNDER the heading "Drastic Proposal" an article appeared in the *Westminster Gazette* a few days ago from the pen of "A Working Man," putting forward what is claimed to be the working man's case for an all-round advance of 5s. a week, and a working week of 48 hours. It is proposed that all Trade Unions shall join in a national demand for the above conditions, and, if the demand be not complied with, shall enforce compliance by means of a general strike.

It might be thought by those outside the Unions that past experience of the results of great strikes would have taught the lesson that this weapon is a very unsafe one to play with, for it generally, one might say invariably, does more damage to the workmen than to the employers.

West Australia is sometimes spoken of as the working man's paradise, and successive Labour Governments have, by class legislation, raised workmen's wages and reduced the hours of labour, all with the idea of improving the position of the workman. The net result is that the Australian Labour Party has now to admit that the purchasing power of the weekly wage has actually fallen; due, of course, to the inevitable rise in prices which shorter hours and higher wages must produce.

Without following "A Working Man" in his argument that "the responsibility for all high prices, low wages and long hours rests upon the shoulders of the manufacturer," let us turn to his reasons for assuming that the effect of a five-shilling rise, coupled with a 48-hours' week, "will be one of universal advantage." His argument is given in the following sentence:—"The more goods there are consumed, the more will have to be manufactured; the more goods there are manufactured, the more people will be employed in the manufacture (for a time, at least); the more people there are engaged in the manufacture of consumable goods, the more wages will be paid; the more wages that are paid, the more will be spent; the more wages spent, the greater will be the return to the employers by the increased demand for goods."

It seems almost too cruel to cast a shadow over so sublime a picture by calling attention to the words which the author has placed in brackets. "*For a time at least.*" How painfully, how pathetically obvious that the wish which was father to this beautiful thought, was not backed by any conviction. "*For a time at least.*" Let us leave it at that.

There are many points in the article that might be referred to, but let us, for the sake of argument, grant the author's premiss that the effect of a 5s. rise and a reduction in working hours all round would be a universal advantage. If 5s., why not 10s.? and if 48 hours, why not 38? It is obvious that if we push the argument far enough, we shall arrive at the conclusion that the hours of labour might, with advantage, be reduced to zero, and the wages increased to infinity. This is obviously absurd, because nothing would

be produced but starvation. If, on the other hand, we push to its limit the idea that longer hours and lower wages would be an advantage, we arrive at the conclusion that infinitely long hours (that is, continuous work) and minimum or zero wages would be the best all-round solution, a conclusion as absurd as the other. Nor can it be said that the one method would benefit the worker and the other the employer; both would suffer.

It is obvious, therefore, that there are other considerations to be taken into account, and the problem is a much bigger one than "A Working Man" would have us believe.

It is interesting to notice that the more thoughtful and sober of the Labour leaders show a disposition to deprecate the use of the strike as an everyday weapon—probably influenced by the unfortunate experiences gained in recent strikes. Mr. Ramsay MacDonald, for instance, dealing with the question of the "minimum wage" at the British Association, said he had come to the conclusion that the best means of attaining the desired end was voluntary arrangement between employers and workmen. Compulsory arbitration, in his opinion, was impracticable in this country, owing to the impossibility of enforcing the awards. The difficulty in the way of voluntary arrangement was that one or two employers might decline to be parties to the agreement, and by paying lower wages would be able to undercut their rivals; this could be overcome by imposing the terms, when drawn up by the best employers and workmen in a given trade, upon the whole of that trade. Sir C. Macara indirectly supported these views, stating that the inquiry conducted by the Industrial Council, of which he was a member, into the observance of industrial agreements had conclusively proved that when perfect organisation existed on both sides, disputes were usually settled without a stoppage of work, and that the recent industrial unrest originated with trades that were not well organised.

As bearing on the "drastic proposal" outlined above, we may also quote the view of Mr. Ramsay Macdonald, who laid down the general principle that the reward of labour must have some relation to the mechanism and system of industry under which the wage operated. They must not make demands for minimum wages or for the workers' share of industry that would paralyse the industrial system and create chaos.

The reckless use of the strike was condemned at the Trade Union Congress last week, and the Syndicalists, who advocate a general strike as a means of bringing the community to its knees, were crushed by an adverse vote of more than 30 to 1. We trust, therefore, that calmer and wiser counsels will prevail, and that conciliation and agreement will take the place of strikes and intimidation in the future.

Superheat and Cylinder Power.

In a recent article in the *Engineer*, Mr. C. R. King has much to say on the effects of superheat. Unfortunately, he bases his article on a misconception, and appears to be arguing on the basis that steam engineers generally proceed on the assumption that the bulk of steam matters, and that, therefore, a pound of superheated steam will do more work than a pound of saturated steam because, being more bulky, it will fill the cylinder to cut-off point more often. This notion is held by some people, and, indeed, it has been put forward editorially in the very journal in which Mr. King's article appears, if memory correctly serves. But the assumption thus made is not universal. Steam men of experience know that the first thing to be done on applying superheat to a fixed cut-off engine is to make the cut-off take place later. Automatic engines do this for themselves. The steam engine is a heat engine, and works by virtue of heat, not by virtue of steam. Steam is but the agent by which the heat performs work. Bulk in steam is not in itself valuable; it is only heat that counts. Now, per cubic foot of space occupied saturated steam contains more heat than superheated steam, and will do more work. The only good which superheat effects is to maintain the steam in the free molecular state—*i.e.*, not in the form of hot water. Water molecules possess no automatic translatory movement by virtue of the heat in them. Such heat is lost for purposes of work. Only when the molecules are so hot that they will travel in space by their heat-generated power of automobility can they do work.

When steam is superheated its increment of heat is less than its increment of volume, and less heat can enter a given cylinder at any given cut-off. The cut-off must therefore be put later. In the saturated steam engine the admission space contains so much steam and so much water. This hot water has been formed by cylinder metal action during admission; it is killed steam. But as the pressure drops behind the moving piston, this hot water begins to boil and produce steam to do more work, though at a great expense of heat, the ebullition being so late and the cylinder being a bad place in which to raise steam, for well-known reasons. From an engine with an unchangeable cut-off, the most work can be got by exceedingly wet steam, but the economy will be very poor.

The most economical engine will be that which carries its steam dry for a certain undetermined distance between the cut-off and the exhaust point. The further the superheat or absolute dryness is carried, the larger must be the cylinder. Large cylinders are necessarily less economical than small cylinders, losing more heat by radiation and other causes. Some engineers are content if the steam will start its expansion just superheated. Others like it to carry superheat up to exhaust point, and others, as Mr. King points out, would even exhaust at 11° of superheat. So let the point be somewhere shorter than the maximum cylinder would demand, *i.e.*, somewhere along the curve of expansion. Mr. King is quite wrong when he states that it is "universally accepted theory" that "superheated steam increases power in the cylinder." The contrary has been put forward in these columns for 20 years. Indeed, superheat has never been put forward in these columns as productive of economy because of any thermodynamic reason. Thermodynamics and entropy have nothing to do with practical superheat. Only engines of the very extreme order, demanding more care than the economy warrants, can gain from superheat anything but that indirect but valuable asset, absence of excessive cylinder condensation.

It has been a misfortune for steam engineering that the academical view of superheat, viz., that its economy is measured by the raising of the T_1 of the thermodynamic equation of efficiency, has been supported by the curious coincidence of Rankine's calculated thermodynamic gain and the actual secured economy. Rankine appears to have accepted the coincidence as a proper occurrence, though he had something to say which showed he had some idea there was cylinder condensation. But he did not get outside the thermodynamic field in "The Steam Engine." Except that saturated steam entering a cylinder implies 20 per cent. or more of water also when expansion begins, saturated steam would not show more power than superheated steam which only carried superheat to the cut-off point. Most moderate men on superheat advocate that the expansion shall start fully dry, which means that, as in all engines, the boiler does all the work up to cut-off point and the steam in the cylinder does all the work during expansion.

Superheat will undoubtedly give economy, but not from thermodynamic causes. We fear Mr. King is only tilting at a windmill that has long faced no wind, for only a few cranks ever did place any credence in the bulk theory of superheat action. The reduced work per unit volume of superheated steam has almost invariably been met by later cut off. Higher pressure is not usually possible in converted engines; and only in plants new *ab initio* is it usually practicable to put in a bigger cylinder or use a higher pressure than is usual in current practice with saturated steam.

THE BRITISH ASSOCIATION.—II.

On Thursday last week Section G joined Section A to hear Prof. Callendar's presidential address, which was abstracted in our last issue. At the conclusion of the address Lord Rayleigh, proposing a vote of thanks, said that Prof. Callendar's references to Sadi Carnot were perfectly justified; it was impossible to value Carnot's work too highly. He doubted whether in using the word "caloric" Carnot intended to convey the same meaning as that which could at this date, in view of subsequent discoveries, be attributed to it. Nevertheless, Carnot's work held good to-day. In speaking of the X-rays, it was worth remarking that even now, 15 years after their discovery, it was doubtful whether they were undulatory or corpuscular in their character.

On Friday the joint discussion (Sections A and G) on wireless telegraphy took place; this was regarded—at any rate, by the engineering profession—as the principal feature of last week's proceedings, and we have, therefore, devoted much space to the report of Prof. Fleming's introductory remarks and to the contributions of other authorities to the discussion. There followed a paper by Dr. Eccles and Mr. A. J. Makower on "The Production of Electrical Oscillations by Spark-Gaps immersed in Running Liquids," and one by Prof. Kennelly and Mr. G. W. Pierce on "The Impedance of Telephone Receivers as affected by the Motion of their Diaphragms;" and Prof. J. T. Morris read a paper on "A Method of Measuring Wind Velocities by Means of Wires Heated by Electricity and Exposed to the Wind." By measuring the temperature of the wind as it strikes the wires, and the current required to maintain exactly constant the temperature of the wires, an exact measure of the velocity of the wind is obtained.

In Section A, on Thursday, several electro-physical papers were read, including one by Prof. R. A. Millikan on "The Discharge by Ultra-Violet Light of High-Speed Electrons."

On Thursday evening there was a reception by the Lord Provost, which was attended by most of the members.

On Friday evening Prof. Bragg, of Leeds University, delivered an "Evening Discourse" on "Radiations Old and New," which was well illustrated with experiments and lantern slides; amongst the latter, photographs by Mr. C. T. R. Wilson, showing by means of condensed moisture in the atmosphere the path of the Alpha rays, were much appreciated.

Saturday was wholly devoted to excursions in the neighbourhood of Dundee.

At a meeting of the General Committee on Friday, Sir W. H. White, K.C.B., F.R.S., was elected President for next year's meeting at Birmingham.

In his address to Section F (Economic Science and Statistical Section), Sir Henry H. Cunynghame, K.C.B., said that Auguste Comte was one of the earliest writers who maintained that the social and political sciences were subject to laws just as exact, though more complicated, as the laws which govern the physical sciences; and he formulated the celebrated principle of the three phases of thought. According to this view all sciences commence with a theological stage, pass through a metaphysical stage, and end by becoming positive.

"One of the signs that a science has passed into the positive stage is that it has been subjected to the laws of mathematics. Mechanics, physics, chemistry and electricity have long since been treated mathematically. Biology has only recently begun to receive mathematical treatment. . . . But all the social sciences are for the most part still in the metaphysical stage. The doctrine of the divine right of kings has only disappeared in order to be replaced by the doctrine of the divine right of majorities. Yet from a positive point of view neither of these stands on a footing much firmer than that of the other. The 'duty of obedience to authority' and the 'right of resistance' are in the same condition. The 'right to work,' 'the right to live,' 'the right to a living wage,' 'the right to the vote' are all metaphysical propositions assumed as axiomatic by various energetic writers and speakers, and are usually advanced with a dogmatism proportioned to the uncertainty of their foundation. Yet on what basis do they rest? One might with equal cogency declare for 'the right of the stronger to destroy the weaker,' 'the duty to improve the race by permitting and encouraging the forcible elimination of the unfit.' . . . Another example is the metaphysical aphorism that every right involves a corresponding duty, so that if I have a right to do a thing it is the duty of others concerned in the action to let me do it. This axiom seems at first sight to have a certain amount of plausibility. But does it follow, from the fact that I have a right to kill my ducks, that it is their duty to come and be killed? . . . Thus also the right to individual property, the right to an equality of enjoyment, the right to an equality of opportunity, the right of an individual to be considered as an end in himself, the duty of an individual to be considered only as part of an organised society, are all metaphysical assumptions having no firm positive basis. Equally baseless is the axiom that wherever the State enjoins a duty, as on a parent to educate his children, the State ought to pay for it; or that a local authority contributing funds to an object has a right in every case to interfere with their administration. Yet these are mere chance specimens of the political dogmas that have for years been flying about, and which emphasise the undoubted fact that politics and social science have not yet entered the positive stage of thought."

"In what stage is Political Economy? It appears still to be the battle-ground of opposite schools. Some there are who tell us that it has 'gone to Saturn.' . . . Is it meant that the so-called laws of economics are not laws at all, and that the whole pretended science is built on false foundations? Or is it meant that those engaged in the practical politics of the country have resolved to legislate in defiance of the laws of economics, and to settle the problems of free trade and protection, the taxation of fixed and movable property, and the regulation of wages, as though these problems were not subjected to any natural laws at all? The latter position would, of course, be particularly dangerous if it turned out that there were laws, and that those laws were being ignored."

"I suppose most economists would agree that (provided suitable meanings are given to the words) 'wages in a free market depend upon the demand and supply of labour.' A legislature, wishing to remedy social inequalities and evils, might resolve to render the market no longer free—to impose a minimum wage, or to put a tax upon wages, or in other ways to regulate them by statute. And legislation might go so far as to render wages wholly dependent on scales fixed by authority or by custom. Or, again, a powerful combination, either of employers or of workmen, might unite to fix rates of wages and render it impossible in practice for any other rates to be paid. Systems established by these means might be wise or foolish, beneficial or injurious. But could it be said that the authors of them had succeeded in sending Political Economy to Saturn? Certainly not. They might have rendered inapplicable that chapter of Political Economy which deals with price as fixed by exchange in a free market, but only to bring the case under the next chapter, entitled "Price as Fixed under Conditions of Monopoly." The Political Economy would be there surely enough, with its laws, and with their consequences for those who ignore its teachings."

"If political action be taken in the field of economics such action will, whether the authors of it wish it or not, be governed by the laws of economics, and those who purpose such action must consider what effect it will have on the flow and investment of capital, the demand for commodities, and, in fact, duly take into account the whole problem. For, if they do not, it is not the laws of supply and demand that will go to Saturn. Again, before setting a scheme of taxation we ought to study the cases in which a tax levied on one class falls on another, as, for instance, a tax intended to be paid by landlords, which really falls upon their tenants; taxes levied on tenants which fall on their landlords; taxes levied on producers that can be shown ultimately to fall on consumers, and taxes levied upon commodities that can be shown to fall on the workmen by whom they are produced. For a tax often resembles an arrow shot into the air; though apparently aimed in a definite direction it may fall one knows not where, obedient to the laws of the incidence

of taxation, just as an arrow in its flight is subject to the inflexible laws of air resistance, friction and gravity."

The President proceeded to establish his claim for economics to come among the exact sciences by the surest test that can be applied—namely, its capability of being demonstrated by means of geometry and mathematics, and affirmed the truth that national economics is subject to laws as exact and unfailing as the laws of physics, chemistry or engineering, which, if neglected by political engineers, will as certainly bring the State to ruin as the miscalculation of a mechanical engineer in designing a boiler, or of a civil engineer in designing a bridge.

On Thursday, September 5th, after the Presidential address to Section G, by Prof. Archibald Barr, a note by Prof. Thornton on the "Ignition of Gaseous Mixtures by Momentary Electric Arcs," was read and briefly discussed, and also the report of the Committee on Gaseous Explosions.

Prof. Thornton's note described an investigation of the least currents, direct and alternating, which were required to ignite gaseous mixtures at different voltages and frequencies. The lower and upper limits of mixture within which ignition was possible were found to be 4·25 and 14 per cent. for fire-damp in air, 6 and 40 per cent. for coal gas. There was a well-defined maximum of sensitiveness to ignition at 7 per cent. in the former, 8·5 per cent. in the latter. With direct voltage the least igniting current was approximately proportional to the reciprocal of the voltage; with alternating voltage the frequency was of more importance, and the current remained constant over a long range of voltage, being higher for methane than for coal gas. The energy of spark which would just ignite the most sensitive mixtures was about 0·10 joule, corresponding to the combustion of 37 c.c. of an 11 per cent. mixture of coal gas. Single sparks therefore gave relatively poor ignition.

It would appear from the results that when alternating current is used for signalling or when there is no continuous sparking at a contact, the risk from electrical signalling in coal mines is extremely small. Where there is sparking as at a vibrating contact the bells must be enclosed in flame-proof cases, or be situated in places which cannot be reached by fire-damp in mixtures approaching 4 per cent.

One of the most important events of the meeting was the joint discussion on Friday, in Sections A and G, on the scientific theory and outstanding problems of wireless telegraphy, of which we give a report.

Prof. J. A. Fleming, D.Sc., F.R.S., presented the subject, of which he is, of course, a master, in a very complete address, which was a summary of the printed paper, and was concluded by a set of queries as to the points which require elucidation, and a strong appeal for a competent committee to arrange experiments (which would, of course, extend over thousands of miles) to investigate them.

The Scientific Theory and Outstanding Problems of Wireless Telegraphy.

By J. A. Fleming, M.A., D.Sc., F.R.S., Professor of Electrical Engineering in the University of London.

(Sections A and G. Abstract.)

Experts in radiotelegraphy are well aware that many of the scientific phenomena are imperfectly understood. If we are to overcome present difficulties and limitations and make fresh advances, it can only be by a thorough comprehension of the physics of wireless telegraphy. Hence it will be more to our advantage to bring combined scientific thoughts to bear upon the matters on which even leading experts differ or are ignorant, rather than let our symposium resolve itself into a discussion on apparatus or systems or the recitation of performances and the record of results.

With the exception of a small number of stations using the Duddell-Poulsen arc generator, nearly all the practical wireless telegraphy in the world is at present (1912) conducted by the following apparatus:—

At each station there is a transmitter which comprises three elements:—

1. A source of high electromotive force which may be a continuous current dynamo and storage battery, an alternator and transformer, or a battery and induction coil giving continuous, alternating or interrupted high-tension electromotive force.

2. A condenser in which the generator stores an electric charge to be suddenly released when a certain potential is attained across a spark gap in the form of an electric discharge passing through a coil in series with the condenser.

3. An open or radiative circuit coupled to the condenser circuit, comprising an antenna or arrangement of elevated air wires, a balancing capacity or counterpoise often buried in the earth, the two being connected through an adjustable inductance coil.

At the receiving station we have also three elements:—

1. An absorbing antenna by which the radiation from the transmitter is picked up, creating in it high-frequency oscillations.

2. A condenser circuit having variable capacity and inductance coupled to the antenna and syntonised to it.

3. Some form of oscillation detector connected in series or parallel with the above condenser which is affected by the oscillations and sets in operation a recording or indicating device which makes a visible or audible signal.

Generally speaking, at any one station the radiating and absorbing antennæ are one and the same, and used for both purposes alternately, and each station has both transmitting and receiving apparatus. The functions are, however, not identical. What is required in the transmitting antenna is a certain height and also free or insulated ends. In the receiving antenna, not only height but surface is required, although this antenna can be laid parallel with and close to the earth and earthed at both ends; but provided it is half a wave length in length it will still absorb a considerable amount of energy from electric waves arriving in its own direction.

The antenna consists of a large number of hard-drawn copper wires, which are upheld by masts or towers in such fashion that the wires form a sort of fan elevated in the air; or they may rise up for a certain height and then be bent downward on all sides, like the ribs of an umbrella. In the case of our battleships, they are groups of parallel wires kept separate by wooden stars and stretched between the masts and then led downwards to the bow and stern of the ship. In the high-power Marconi stations, they rise up vertically for a certain distance and are then stretched horizontally for a distance about five times greater, parallel with the ground.

In long-distance stations the wooden or steel lattice towers or tubular masts required to sustain these wires are elaborate structures 100 to 400 ft. or more in height, and have to be well stayed to resist wind.

Associated with the antenna is a counterpoise or balancing capacity, which may consist of insulated wires stretched a little way above the earth, or radiating wires or metal nets laid in the earth, or sheets or nets of metal laid on the ground, or even the metal hull of a ship.

This counterpoise is connected to the antenna through a variable inductance coil. In virtue of the capacity of the antenna with respect to the earth or the counterpoise, the whole system has a natural time period of electrical oscillation. It may be compared with an elastic steel strip held at the bottom in a vice and loaded at the top, which can be set in vibration by small blows administered to it at the proper rate.

There are certain rates of antenna oscillation reserved for certain purposes. Thus, for ship or coast signalling, antennæ are used having natural time periods of one-millionth or one half-millionth of a second, and for large power stations the time period may be as large as one hundred-thousandth or one fifty-thousandth of a second.

In nearly all cases these oscillations are excited in the antenna by the intermittent discharge of a condenser. They are therefore damped or decadent trains of free oscillations, separated by intervals of silence. The group frequency as it is called, or number of the trains of oscillations is now usually 500 to 1,000, since when using the telephone as a receiver the group frequency is preferably that frequency for which the telephone is most sensitive. Each train of oscillations may comprise 30, 50 or 100 oscillations having the antenna frequency. The antenna is, therefore, set in electrical vibration, so that trains of electric currents run up and down it intermittently, say, 500 times a second, each train consisting of 50 or more decadent oscillations, whilst each oscillation or single current occupies a time between one fifty-thousandth of a second and one two-millionth of a second for its complete to and fro cycle.

These high-frequency currents in the antenna are created by the induction of a nearly dead-beat or else an oscillatory discharge of a condenser. In small installations the condenser is a collection of Leyden jars, or, more conveniently, glass plates coated with thin sheet zinc or tin, the plates being immersed in a metal or stoneware box of oil. In the case of some high-power stations, Mr. Marconi employs large air condensers consisting of sheets of metal hung up on insulators in a room. At Nauen and at the Eiffel Tower stations tubular or plate-glass condensers are used.

The condenser is charged by the source of electromotive force to a high potential, and then discharged across a spark gap, with or without oscillations, and this discharge passes through a coil which may be one coil of a two-coil transformer, the secondary being inserted in the circuit of the antenna, or else a single-coil transformer, then called an auto-transformer, may be made to do duty for the two separate coils in the circuits of the antenna and the storage condenser.

An important element is the spark gap. In early days when only small powers were employed, this consisted simply of two stationary brass balls. When large power first began to be applied as at the Poldhu Station in 1901, it was soon found that the oscillatory discharge started an electric arc across the balls which had to be extinguished before the condenser could again become charged. Also the balls became rapidly worn away. To remedy these defects various inventions were introduced. An air blast was applied to the spark gap to quench the arc.

I devised for the Marconi Co. in 1902 a discharger with revolving balls or disks driven by an electric motor which overcame some of the difficulties, and this type of slowly rotating disk discharger using low-frequency sparks was used for some considerable time at Poldhu. Later on Mr. Marconi invented his high-speed studded disk discharger, which is far more efficient, and creates a quenched musical spark of the required character. In this discharger a steel disk having studs on it revolves at a high speed between two other revolving electrodes and the passage of the studs starts a condenser discharge in which any true arc is instantly quenched. The kind of discharge required for effective work is one in which rapidly

repeated, strong, highly damped discharges take place in the primary condenser circuit, and these excite prolonged trains of free oscillations in the antenna. This is only possible if any true arc discharge in the primary circuit is entirely prevented.

This is also achieved by the Wien or Telefunken, the Peukert and Von Lepel dischargers consisting of flat metal plates in close proximity. In these dischargers the discharges succeed each other with great regularity and at the rate of several hundred per second. When the condenser circuit is properly tuned to the antenna circuit and coupled to it not too strongly (with about 20 per cent. coupling), we have powerful intermittent oscillations set up in the antenna, each group being very feebly damped and of uniform oscillation frequency. These rapidly succeeding groups of oscillations are cut up into groups of groups in accordance with the signals of the Morse alphabet by means of a key placed in some part of the circuit. Although nearly all the radiotelegraphy in the world is now conducted by means of these intermittent condenser oscillations, great efforts are being made to perfect suitable high-frequency high-power alternators, and the advent of a commercial machine of this kind will no doubt make it a formidable rival to the existing methods.

In the sending antenna we have very powerful high-frequency currents at the base and high potentials at the free or upper end. Even in small stations the sending antenna current may have a value of 5 to 10 amperes, whilst in large stations the antenna current at the earthed end is 50 to 100 amperes and large enough to raise to incandescence quite large rods of arc light carbon.

There is, therefore, a considerable expenditure of power on the antenna. Part of this is spent in heating the antenna, but a large proportion is radiated. Nevertheless the over-all efficiency of the usual wireless telegraph transmitter using the ordinary unquenched condenser spark, meaning by that the ratio of power radiated from the antenna to power supplied by the operating dynamo or battery, is at present probably not more than 20 per cent. to 25 per cent. in actual practice, though much higher efficiencies, even up to 75 per cent., have been claimed for the quenched-spark system. But the evidence for these high efficiencies is somewhat imperfect.

An extremely small fraction of the whole radiated energy is picked up by the receiving antenna. In the latter we have currents created which are measured in micro-amperes, or, at best, in fractions of a milliampere. If the receiving antenna is properly tuned to a closed condenser circuit inductively coupled to it, the energy picked up by the receiving antenna accumulates in the associated condenser circuit.

In this last we then have feeble currents circulating which imitate in mode of variation those of the distant transmitting antenna. To detect them, it is now most usual to employ a telephone in series with some form of current rectifier, which is shunted across the condenser in the closed secondary receiving circuit, or else some form of current-operated detector, such as Marconi's magnetic detector which is placed in the condenser circuit.

If we merely connect a telephone across the condenser circuit, no sound will be produced in it, because the frequency of the current oscillations in the receiving condenser circuit is too high to affect a telephone. If, however, we insert some device in series with the telephone which acts like a valve, it will rectify the groups of oscillations into prolonged gushes of electricity in one direction, which, coming at the rate of the much lower spark frequency, say, about 500 or 1,000 per second, create in the telephone a shrill sound. As these groups are interrupted at the sending station in accordance with the Morse signals, the receiving operator hears long or short musical sounds which he can interpret into the letters of the alphabet.

Amongst the rectifiers much used my own oscillation valve invented in 1904, or glow lamp detector, is an interesting example. It consists of a little electric glow lamp, having a metal plate or cylinder sealed into the glass bulb. When the filament is incandescent the space between the filament and the plate has a unidirectional conductivity, and will allow negative electricity to pass from the filament to the plate but not in the opposite direction.

Another large class of oscillation rectifiers, are the crystal and contact rectifiers, the first of which, viz., carborundum, was discovered by Dunwoody, others by Pierce and Pickard. Thus, for instance, a copper point pressed against a small mass of molybdenite is a good rectifier. Also the minerals chalcopyrite, zincite, bornite, anatase and hessite possess similar properties, and a very sensitive rectifier is made by a slight contact between two small masses of zincite and bornite. Another rectifier is the galena-plumbago rectifier Also a gold point pressed very lightly against an artificial surface of iron pyrites (ferric disulphide) makes an excellent detector.

In spite of much valuable work done by Prof. G. W. Pierce, G. W. Pickard and others the action of these crystal rectifiers is by no means fully elucidated. It appears not to be thermoelectric, since in general the rectified current is in the opposite direction to the thermoelectric current produced by heating the junction.

In addition to these glow-lamp and crystal rectifiers another much used detector is Marconi's magnetic detector in which a slowly moving band of iron wires passes across the poles of a pair of horseshoe magnets. The wire at that place is embraced by two other coils of wire—one in series with the oscillating circuit of the receiver and the other with a telephone. When trains of oscillations are set up in the receiving antenna a listener at the telephone hears a sound due to the sudden change in the magnetic state of the iron. The simplicity and absence of any difficult adjustments make this magnetic detector one of the most useful for general purposes.

The wireless message is thus picked up at the receiving station by hearing telephonic sounds due to a greater or less number of trains of high-frequency oscillations in the transmitting antenna corresponding to *dashes* or *dots* in the Morse alphabet.

These long or short groups of oscillations in the transmitting antenna create similar groups in the receiving antenna, which when rectified cause gushes of electricity in one direction through the telephone, and therefore make sounds like ticks or musical notes of long or short duration. The pitch of this note is the frequency of the spark at the sending station.

One of the practical difficulties not yet quite overcome, is the invention of a suitably simple and sensitive *call* signal. At present the operators have to sit with the telephone on their heads waiting for any message which may begin, and this is expert work which cannot be deputed to anyone else.* Another requirement is a simple and yet sensitive relay by which the messages may be printed on paper tape. The photographic method employing the Einthoven galvanometer is effective but rather elaborate.

The recently invented alternating-current resonance relay of Dr. Kapp and Mr. H. Von Kramer is sensitive, and can be operated with an alternating current having a frequency of about 100, and one-fifth of a milliampere in value. What is required is a relay sensitive to currents of a frequency varying between 50 and 500 or so, and a strength of about one-tenth of a microampere.

Having thus outlined the manner in which the radiotelegraphic message is sent, I now pass on to propound for your discussion certain imperfectly solved scientific questions. The first of these is :—

By what mechanism or process are the signals conveyed across the intervening space between the transmitter and the receiver? Most persons would say, at once, by electromagnetic or Hertzian waves, produced in the æther, and the answer is no doubt correct as far as it goes. The action of the sending antenna on the receiving antenna is not merely an instance of one electric current inducing another in a secondary circuit as in the magnetic induction form of telegraphy. In radiotelegraphy the energy sent out from the sender, no doubt, departs from it entirely and exists for a time in a medium before it reaches the receiver. The question is what is that medium? The whole of the actions in the sending antenna by which the distance effect is produced are consistent with the assumption that electromagnetic waves are sent out from it. But are these waves, strictly speaking, Hertzian waves or space waves? What part, if any, does the earth play in the process? Are the very long distances which can be covered by modern radiotelegraphy consistent with the properties of pure Maxwellian or Hertzian waves produced in the æther? These are the first unsettled questions I wish to throw down for discussion. As soon as transatlantic signals had been received by the means already described, physicists began to ask how such waves, if they are true electromagnetic waves, are propagated one-eighth of the way round the earth. Since then Mr. Marconi has achieved the feat of receiving signals in South America from his Clifden station in Ireland at a distance of 6,000 miles. The problem now is to explain how this effect travels one-quarter of the way round the earth. It suggests at once the query, could it go half-way round? Can wireless signals be received in New Zealand from England, and may we look forward not merely to transatlantic or transpacific, but to transterrestrial wireless telegraphy to the Antipodes as a practical possibility? The answer to these questions is necessarily connected with that to the more general question, how does the sending antenna affect the receiving antenna at any distance? In a year or more, when the Imperial wireless scheme comes into operation and the long-distance stations are completed, London will speak to Aden ; Aden to Bangalore and Pretoria ; Bangalore to Singapore ; and from thence the step will be easy to Australia and New Zealand. It is possible that we may yet communicate from London direct to Melbourne without the intermediate stations. In text-books and lectures it has been usual, for the sake of simplicity, to treat the problem of radiotelegraphy as if the earth were a perfectly conducting sphere immersed in free æther. A very little practical experience showed wireless telegraphists that the electric condition of the atmosphere greatly affected it, and that the receiving apparatus, so sensitive to waves intelligently sent out from transmitting stations, picked up in addition all manner of vagrant waves set going by atmospheric discharges. Also early attempts at long-distance radiotelegraphy led Marconi to the discovery of the great influence of daylight upon the distances attainable. If, however, we leave out of account for the present these atmospheric and daylight disturbances, to which we shall return presently, we have still to face the fact that the nature of the terrestrial surface between the sending and receiving station affects the result very appreciably.

Very early in the practical experience of radiotelegraphy it was found that it could be conducted more easily over sea than over land, and more easily over ordinary wet soil than over very dry sandy soil.

But apart altogether from this last effect, it has always been felt that there was something surprising in the fact that it is possible to detect electromagnetic waves created at a distance of one-eighth to one-quarter of the way round the world. It has been generally assumed that this was wholly due to an abnormally large diffraction effect. The first question of importance is, then, whether diffraction can occur to an extent sufficient to account for the observed facts. The determining factor as regards diffraction is the ratio of wave-length to the earth's diameter.

* The Marconi Co. have recently introduced a call instrument, in which a signal equivalent to a prolonged *dash* on the Morse code deflects a galvanometer, which in turn closes a bell-battery circuit and rings a bell. The difficulty is, however, to prevent atmospheric discharges from making a false call, and to render it sensitive only to a prearranged signal.

In the early attempts at long-distance wireless telegraphy wave lengths of 2,000 to 3,000 ft. were used, but at the present time wave lengths from 10,000 to 20,000 ft. are employed, or say one-thousandth of the earth's radius.

Consider for one moment an optical analogue. The mean wave length of visible light is about 1/50,000th of an inch. Suppose a luminous point of infinitely small magnitude were placed at the pole on the surface of a smooth sphere ½ of an inch in diameter or about the size of a pea, in a region otherwise not illuminated. This corresponds to the case of electric waves 1,000 metres in wave length sent out from a radiotelegraphic station on the earth's surface. Would there be any light due to diffraction at the equator or even at 45° latitude of this small sphere? It is essentially the province of the mathematical physicists to give us a solution of the above question, but the answer would I think be in the negative. To make the case comparable with that of the longest electric waves used for terrestrial radiotelegraphy, the sphere would have to be only one millimetre in diameter. The answer is then not quite so obvious.

The first attempt at the problem in the case of radiotelegraphic waves was made by Prof. H. M. Macdonald in 1903 and 1904.

Last year he published another paper in the *Transactions* of the Royal Society on the same subject.

The same problem has also been discussed by Prof. H. Poincaré, whose recent decease we have so greatly to deplore, in a series of interesting lectures and papers. His work agrees with one result of practical experience, viz., that to effect radiotelegraphy over long distances large wave lengths are necessary. But it is difficult to extract from his conclusions means to enable us to predict the exact extent to which diffraction really exists for waves 2 to 4 miles in length.

The problem of the bending of electric waves round the earth has also been discussed by Dr. J. W. Nicholson in a series of able and critical papers.

If his result is confirmed for wave lengths of 4 miles, or one-thousandth part of the earth's mean radius, then it will follow that ordinary diffraction is incapable of explaining long-distance radiotelegraphy, and we must look to some other cause. Mathematicians who have dealt with the problem under the assumption of a perfectly conducting earth and a Hertzian oscillator entirely disconnected from it, have assumed conditions which do not hold good in practice. Hence the attempt to explain long-distance radiotelegraphy by the aid of diffraction may be a quite unnecessary effort. The actual earth has a crust composed of materials which chiefly owe their conductivity to water. When free from water these materials composing the igneous and sedimentary rocks are very fairly good insulators. Although sea water is a conductor, it has a dielectric constant ($K = 80$) very far from infinite. Moreover, at no very great depth in the crust the temperature is sufficiently high to exclude the presence of liquid water, and therefore of any conduction due to it.

The problem of the propagation of electric waves over the earth's surface involves, therefore, three important factors which greatly influence the result, first the imperfect conductivity and rather high dielectric constant of the earth, making it a semi-dielectric. Secondly, the effects of atmospheric ionisation, natural electrification and sunlight, and, thirdly, the earth's curvature. The German mathematical physicists have of late years considered the first of these factors very carefully, and arrived at some interesting results. Prof. A. Sommerfeld published in 1909 a very able paper on the propagation of the waves in wireless telegraphy over the earth's surface.

He shows that part of the radiation is a surface or cylindrical wave which follows round the surface, and is quite analogous to the electromagnetic waves produced on wires. These waves are very rapidly damped in a downward direction, and they suffer damping in a horizontal direction or in the direction of propagation.

The other quantities correspond to space waves, and the amplitudes of the forces derived from this part of the total potential vary inversely as the square of the distance.

It is, of course, not new to suggest that the waves involved in radiotelegraphy resemble electric waves on wires or are surface waves. It was long ago surmised that the sending antenna, the earth and the receiving antenna might be regarded as one single oscillator in which oscillations were set up. This view has been held, amongst others, by A. Blondel, E. Lecher, and F. G. Baily.

Prof. Baily pointed out in 1903 that the energy of surface waves would decrease only inversely as the distance, and therefore at large distances survive when space waves would have vanished. The strict mathematical proof of their possibility has, however, only lately been given.

The space waves are subject to diffraction, and are hindered by obstacles. On the other hand, the surface waves pass round, and are unhindered, apart from damping, by the curvature of the surface. Also, owing to the surface waves decreasing in amplitude less fast with distance, the surface waves survive when the space waves are extinguished. If, then, Sommerfeld's investigation is valid, we need no longer seek for an explanation of such achievements as the detection of electromagnetic waves one-quarter of the way round the earth in any abnormal diffraction. If Sommerfeld is right, diffraction has nothing to do with the matter. The effect at such distances is entirely due to these "Oberflächenwellen," or surface waves, which, like electric waves on wires, are propagated along the surface, no matter what the curvature may be. There is a certain analogy between these space and surface electric waves, and corresponding effects in the case of earthquakes. From the time of Poisson, it has been known that a shock communicated to an elastic solid created in it two waves, one of dilatation and one of distorsion, travelling at different speeds through the mass.

In 1885, Lord Rayleigh showed that, in addition, there was a surface wave dependent on the fact that the surface can be distorted, and resists distorsion with a different elasticity to that of the interior of the mass.

These effects are recognised by seismologists as represented in the preliminary tremors and main shock in an earthquake.

In this case, two kinds of disturbance are found to be propagated through the earth, with velocities of 10 and 5 km. per second respectively. Also another main shock arrives later, which moves with a speed of about 3 km. per second. The latter is a surface wave travelling along the surface crust of the earth, and the two former are space waves travelling through the mass.

In the same manner we can say that in wireless telegraphy we are concerned with three waves—one travelling through the air above the earth, the second through the crust of the earth, and the third a surface or cylindrical wave, which is confined to a limited region at the boundary of the two dielectrics.

The conclusion drawn from Sommerfeld's work is that for the achievement of long distances in radio-telegraphy, waves of long wave length are necessary, as shown by experience.

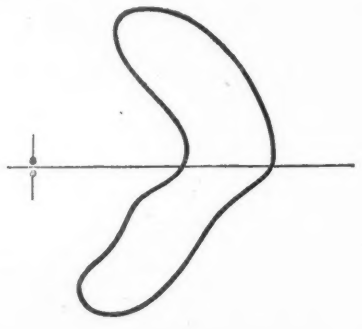
On the other hand, the radiation from the antenna decreases with increasing wave length. Hence there is probably a certain maximum wave length which is most effective for signalling over a given distance and surface.

It is suggested, however, that long-distance radiotelegraphy is chiefly effected by means of the surface waves or "Oberflächenwellen" of Sommerfeld, which fall off in amplitude inversely as the square root of the distance and are not limited by diffraction as they follow round the surface. The earth's curvature limits the range of the space waves seriously but does not so limit the surface waves.

One difficulty in reading Sommerfeld's paper is that he does not sufficiently translate his mathematical analysis into physical concepts. Hence it is desirable to consider a little in general terms how these surface waves arise.

If we have two media of different dielectric constants in contiguity, and if a line of electric force crosses the boundary, then it is well known that the conditions to be fulfilled are that the tangential component of the electric force on either side of the boundary must be continuous, and also the normal component of the electric displacement or flux must be continuous. This involves a refraction of the line of electric force in crossing the boundary. It is bent away from or towards the normal, and if K_1 and K_2 are the dielectric constants and θ_1 and θ_2 the angles the line makes with the normal, then $K_1 \cot \theta_1 = K_2 \cot \theta_2$. The law of refraction of light is $\mu_1 \sin \theta_1 = \mu_2 \sin \theta_2$. Hence, in the case of light, the velocities of the rays in the two media respectively are proportional to the sines of the angles of incidence and refraction. In the case of the electric force, the velocities are inversely as the square roots of the tangents of the angles of incidence and refraction of the lines of electric force.

If, then, we consider a Hertzian oscillator which is partly in one medium and partly in another of greater dielectric constant, there will be a distortion at the boundary of the loops of electric force which are thrown off at each oscillation. If the upper medium is air and the lower medium is a material of greater dielectric constant, then corresponding to a normal semi-loop of electric force or air, there will be a completing semi-loop in the other material which is sheared backward, as shown in the diagram. If in the air at the



boundary surface, the force is normal to the surface, it will not be normal just below that surface in the medium of greater dielectric constant. It will have a longitudinal component. As the oscillations take place, these longitudinal components of the force are periodic in space and time, and constitute the surface wave which is similar to the electric waves produced on wires.

If the earth were a perfect conductor, say, a ball of copper at the absolute zero of temperature, these surface waves would be confined merely to the surface skin. In the case of the actual earth, even sea water is a sufficiently poor conductor to allow the penetration of the surface wave to some little depth in it.

The objection has been raised that no experimental proof has been given of the actual existence of Sommerfeld's surface waves. Against this it should be noted that Sommerfeld has carefully explained that the surface waves are not separated sharply from the space waves, and may be regarded merely as a particular distribution of the moving electrostatic field near the common surface of the air and earth and accompanying electric currents in the earth. It is easy to prove that we can have surface electromagnetic waves on a *sheet*, similar in nature to electromagnetic

surface waves on wires, of the existence of which we have abundant experimental proof. An argument in favour of the existence of these surface waves may perhaps be derived from the experience that high antennæ do not seem necessary for the *reception* of signals, even over long distances, thus indicating that there is a concentrated electric and magnetic field near the surface of the earth.

P. Epstein has delineated from Sommerfeld's equations a portion of the field of electrostatic force round an oscillator placed first over a perfectly conducting earth, and, secondly, over an earth of finite conductivity. In the first case the loops of lines of electrostatic force are seen to terminate perpendicularly on the earth, and are divided symmetrically by the surface plane. In the second case they are distorted so that the lines at spaced intervals do not terminate perpendicularly. If, however, they have a component parallel to the earth's surface this is equivalent to a combination with a true space or Hertzian wave of a surface wave, similar to the electric waves on wires, which latter can travel along the guiding surface, irrespective of curvature of that surface.

If these conclusions are valid there is nothing to prevent the surface waves going half round the earth. It may, therefore, be quite possible to communicate by radiotelegraphy direct from England to New Zealand. There is one matter which may be of importance. Since the surface waves started from any one point reach an antipodal point by different paths it may be that unless the position of the receiving station is rightly selected, interference will arise between surface waves reaching it by different lengths of path, and hence extinction of signals for some places but not others in the same region. According to this theory, then, we need not endeavour to explain long-distance radiotelegraphy by diffraction, because true space waves are very little concerned with it.

We pass on then to consider the next question, viz., the influence of the nature of the surface in radiotelegraphy. Why, for instance, it is conducted with certain wave lengths so much more readily over sea than land.

This matter has been particularly considered by Dr. Zenneck in an interesting paper. Assuming for the sake of simplicity a plane earth and plane electromagnetic waves, he discusses the effect of the conductivity and dielectric constant of the earth's crust on the wave propagation.

Starting from the same equations as Sommerfeld, he arrives at an expression which enables him to calculate the damping of the waves along the horizontal boundary surface. He shows that this damping is determined by the dielectric constant and conductivity of the earth's crust. He calculates the distance the plane wave must travel before its amplitude is reduced to $1/e$ of that at the transmitter, and exhibits the results for various values of the dielectric constant and conductivity in the form of curves. Waves 1,000 ft. in length over a sea surface would travel 10,000 km. before reduction to $1/e$ in amplitude, but over very dry soil only for 10 km. or less. The analysis shows that there is a considerable penetration of the wave into dry soil, but into so good a conductor as sea water the penetration is at most a metre or two. Moreover, Zenneck shows that over sea surface the lines of electrostatic force terminate nearly perpendicularly to it, but over a dry surface this is not the case. Zenneck's results have been extended by F. Hack, who has shown that underground moisture has the same effect as surface moisture in preventing degradation of amplitude.

The general result of these investigations, compared with practical experience, is to show that we can by no means consider the earth to be a perfect conductor in the case of radiotelegraphy, but that it has an extremely influential action in degrading the amplitude of the waves deforming the travelling electrostatic field, and creating a type of surface wave which attenuates much less fast than a pure Hertzian wave and can travel round the curvature of the earth quite easily.

On the whole, we may say that the theory, as given by Zenneck and Sommerfeld is a valuable attempt to bridge over the very serious gap in our knowledge of the reasons for certain well-ascertained facts in radiotelegraphy. Nevertheless, there are still unexplained difficulties.

Another unsolved problem in radiotelegraphy is the explanation of the effects of the atmospheric conditions and daylight upon it.

The suggested explanations are in many respects imperfect. In the earliest days of radiotelegraphy it was found that atmospheric electric discharges produced irregular and false signals, which sometimes greatly interfered with working. These were more objectionable at the time when the receiving instrument was a coherer of some kind associated with the Morse printer. Nowadays, when the reception is by telephone, it is usual to have the spark frequency at the sender high enough to give a shrill note in the telephone. The receiving operator can then distinguish, to a great extent, between the clear musical note of the right signals and the lower squeaks or grunts in the telephone, due to atmospheric discharges. Nevertheless, at certain times and in certain regions the so-called atmospherics present serious obstacles to radiotelegraphic communication.

When we turn to the effect of sunlight on the propagation of radiotelegraphic waves which was discovered and described by Mr. Marconi in 1902, we find that even after 10 years we are still intellectually speaking very much in the dark as to the reason for this daylight effect.

The first observation made by him in 1902 was that by night signals could be received over sea from the Poldhu station at a distance of 2,099 miles, whereas by day the same kind and type of signal ceased to be detectable at about 700 miles. Also that at the time when the sun rose over the sending station the signals at 700 miles' distance quite quickly became very weak.

Of recent years he has noticed that in the morning or evening when the boundary between light and darkness occurs about half-way across the Atlantic, signals sent across become weak. Also he has noticed that in sending with a coupled transmitter radiating waves of two wave lengths, whereas the longer wave length is the one generally received, there are certain periods at sunrise and sunset when the shorter wave gives the best signals.

It has also been pointed out, both by Mr. Marconi and Mr. G. W. Pickard, that soon after the time of sunrise at the sending station there is a very pronounced decrease in the strength of the signals received a few hundred miles, or at some considerable distance from a power station, but that after sunrise there is a partial recovery of strength. There is also a gradual rise in the strength of the signals soon after sunset, and a very pronounced maximum value after or about midnight. An interesting curve has been given by Prof. Pierce in his book on "Wireless Telegraphy," p. 135, taken from Pickard's observations showing the general variation of the strength of received signals at a distance of 600 miles from the Marconi station at Glace Bay during the hours of the day and night. It appears that the current in the receiving telephone at midnight was about 30 times greater than by day. Confirmatory observations have been published by the Telefunken Co.

Two theories have, so far, been proposed to explain this effect :—

1. The original suggestion of Mr. Marconi (which has been tentatively adopted by Prof. Zenneck) was that it is due to the effect of light in discharging the sending antenna, so that it does not reach at each oscillation such a high potential by day as in darkness.

2. The theory that the daylight effect is due to the ionisation of the air by sunlight, giving it increased conductivity, and so producing absorption of the electric waves.

Neither of these theories seems to meet all the facts. If the daylight effect were an action of light on the sending antenna alone, it should be produced independently of the distance of the receiving station, whereas it is essentially a cumulative or long-distance effect.

Again, so far as measurements of the electric conductivity of air have been made, they do not give support to the theory that the daylight effect is due to air conductivity produced by ionisation, because measurements of this conductivity show it to be too small to account for the observed wave attenuation.

Prof. G. W. Pierce has made calculations which show that the air conductivity would have to be 100,000 times greater than it actually is to account for even a part of the observed effect at 3,000 km. distance.

Prof. Zenneck also agrees that atmospheric conductivity by ionisation cannot account for the phenomena.

It is possible that some part of the effect may be due to actions taking place quite close to the sending antenna. This view may be supported by the interesting observations made during the nearly total solar eclipse on April 17th last, on the effect of the temporary diminution of daylight on the strength of radiotelegraphic signals.

Whilst visiting the Eiffel Tower station at Paris, Commander Ferrié, who is in charge of this station, informed me that a slight increase in the strength of the signals at distant receiving stations had been noticed at the time of greatest obscuration of the sun at Paris. Also in Denmark, Mr. H. Schledermann stated in a letter to the *Electrician*, that observations made between the Royal Dockyard station in Copenhagen and the Blaavands Huk Lighthouse on the North Sea, at 300 km. distance, showed that during totality the signal strength was increased.

Also in England, Dr. Eccles noted an increase in the strength of atmospheric strays and signals from Clifden, observed in London during greatest obscuration. These observations show that even a partial diminution of the sun's light is sufficient to increase the strength of radiotelegraphic signals, possibly by an action on the air between the station and especially on that near the transmitting station.

Another possible explanation of this daylight diminution has, however, occurred to me which I should like to submit to you. It is well-known that sound is better heard when the wind is blowing from the source to the observer than when it blows in the opposite direction. It is also known that there are curious vagaries in sound transmission whereby loud sounds are heard sometimes better at great than at short distances. These effects were explained by Sir George Stokes as due to the fact that the velocity of sound is greater when moving with the wind than against the wind. Now, owing to friction and other causes, the velocity of the wind is generally greater at a height above the earth's surface than at the ground level. Hence, if a sound wave is travelling outwards from a centre against the wind, the upper parts move more slowly than the lower parts of the wave front, and hence the ray direction is tilted up and the sound passes over the observer's head.

The suggestion I venture to make is that when the upper layers of the air are ionised, the ions act as condensation nuclei for water vapour, and the presence of these numerous water spherules gives the upper air a larger dielectric constant. Therefore an electric wave moves more slowly in it than in non-ionised air. Hence, if a plane wave is moving parallel to the earth's surface and the upper layers of air are ionised by light, the greater velocity of the wave front at the lower levels causes it to slope backwards and the direction of the ray is elevated, so that it may pass above the receiving antenna and not affect it.

This tilting-up of the ray will occur when the ionisation of the upper air has taken place over a part of the interval between the stations. It will be most pronounced when the greatest difference exists between the dielectric constant at the earth level and that at a level a few miles up in the air. At very large distances, say 2,000 miles, an ex-

tremely small difference in the dielectric constant of the air at low and at high levels would be sufficient to give the wave front a sufficient tilt to make the waves pass far above a receiving antenna 200 ft. high, and so weaken immensely the received signals because the effect is cumulative and noticeable therefore only at very great distances. As an experimental contribution to the subject I have made some preliminary observations on the dielectric constant of air, filled more or less with damp steam or warm mist. A tubular condenser was constructed of such kind that steam from a small boiler could be blown between the tubes, and the tubes were so supported that the condensation of the steam could cause no loss of insulation. The electrical capacity of this condenser was determined carefully by the Fleming and Dyke capacity bridge, using a telephone as a detector, and alternating currents having a frequency of 2,760. Employing all necessary precautions, and comparing the dielectric constant taken as unity of air nearly saturated with water vapour, with air having water globules or damp steam in it, we found that the dielectric constant of air filled with water spherules varied from 1·026 to 1·004, according to the amount of damp steam present in the space. In other words, an electric wave would travel more slowly in the steam-impregnated air than in the ordinary saturated air in the ratio of 980 to 1,000, or 998 to 1,000, or anything between these limits.

If, then, we consider a plane electromagnetic wave travelling with plane vertical and its lower end in ordinary air and its upper end in air containing minute water spherules, the upper end would travel more slowly than the lower, and the wave front would acquire a backward tilt sufficient, in a distance of a few hundred miles, to carry the wave right above an ordinary receiving antenna. If the ionisation of the upper air by ultra-violet light results in the production of condensation nuclei, which condense water vapour round them, then it is highly probable that the upper levels of the air have a slightly greater dielectric constant than the lower, and a difference of even a very small fraction of 1 per cent. will be cumulative in its action on the wave in giving the wave front a backward tilt in travelling over long distances.

Mr. Marconi states that over the Atlantic he has found the maximum daylight effect to occur when the shadow boundary was about halfway across the Atlantic, the sending station being in daylight and the receiving station in darkness. I think the well-known "sunrise nick" in the signal intensity curve is due to the fact that the effect is at a maximum when the greatest difference exists between the state of the upper air as regards ionisation and that near the earth. Later in the day convection currents arise to churn up the air and bring it more into a homogeneous condition, which, whatever may be the state of ionisation, is unproductive of any tilt in the wave front.

It has been frequently suggested that an explanation of long-distance radiotelegraphy may be found in the reflection of the electromagnetic waves at the under surface of a layer of ionised air in the upper atmosphere. No proof, however, has been given that this hypothetical layer of ionised air has a sufficiently defined surface to cause wave reflection. Hence, it is improbable that anything like copious reflection of long electromagnetic waves could take place at the under surface of a layer of ionised air. This point, however, is one open for discussion. It is true that refraction may produce a change of ray direction which simulates reflection as in the case of the phenomenon of the mirage. In this case the intense heat of the earth expands the layer of air next to it, and lowers its refractive index. Hence, the lower end of a plane wave of obliquely incident light, travels faster than the upper end, and may do so to an extent sufficient to swing the ray right round, as if it were reflected from the layer of heated air. For a similar effect to occur with radiotelegraphic waves, it would be necessary for the upper end of the wave front to travel much *faster* than the lower end. In other words, the upper end must be in a region of less dielectric constant than the lower end.

Since the above remarks were put in type, a valuable paper has been published by Dr. Eccles (see *Proceedings* Roy. Soc., Vol. LXXXVII A, page 79, 1912, on "The Diurnal Variations of Electric Waves occurring in Nature, and on the Propagation of Electric Waves round the Bend of the Earth") in which a theory is developed of electric wave propagation in ionised air. He gives a mathematical proof that under certain assumptions as to the mass of these ions the wave velocity would be increased as compared with that in unionised air, and hence that a plane vertical wave front travelling with lower end near the earth and upper end in air more or less ionised by sunlight, would be caused to lean forward by the increased velocity of its upper end. Hence he proves that, according to wave length and circumstances, the wave may be better able to follow round the earth's curvature, or may be prevented from doing it.

On this basis he has developed a theory of long-distance radiotelegraphy and of the inhibition of daylight upon it. The chief criticism to which I think his theory is open is that he assumes that the dielectric constant of the air is unaffected by the ionisation or condensation of water vapour on these ions. This is not absolutely certain. We know that in the case of solutions in a state of ionisation, such as dilute solutions of metallic hydrates in water, the dielectric constant of the solvent is considerably increased. As a rule, anything which increases conductivity in a dielectric increases also the dielectric coefficient. Hence ionisation may do so in the case of air. If the dielectric constant (K) is increased by ionisation, then in the expression given by Dr. Eccles for the wave velocity that velocity may be more reduced by this increase in K than it is increased by the presence of the ions.

It would seem, therefore, most necessary to settle by experiment whether the wave velocity is increased or diminished by the presence of the ions due to ultra-violet light before we can base a theory upon the constancy of the dielectric coefficient.

There is no doubt, however, that the earth's atmosphere contains something which acts at times towards radiotelegraphic waves like a fog or mist towards light waves.

There are also occasions of unusual transparency when waves 300 or 600 metres in length seem to travel round the world in an extraordinary manner. Ships provided with the ordinary ship transmitters and receivers occasionally pick up signals sent 1,000 miles away. This is not due to special operative skill but to a temporary transparency of the atmosphere to radiotelegraphic waves.

The next question to which I should like to direct attention is to the present state of the theory of directive antennæ. I need not go very fully into the early history. Mr. Marconi pointed out in 1906 the special qualities of an antenna, consisting of a long wire arranged so that part is vertical, but the greater part horizontal, and that radiation takes place most energetically in the opposite direction to that in which the free end of the horizontal wire points. Also by the law of exchanges a bent antenna which radiates unequally absorbs unequally in different azimuths. The question is as to the explanation of the action of this bent antenna.

In 1906, starting from a suggestion by Sir Joseph Larmor, I gave a theory based on the view that the bent antenna is equivalent to a combination of an open and closed circuit and assumed the earth to be a perfect conductor. The objection has been raised to this theory that it implies that the directivity should fall off with distance.

Experiments have not yet been made as far as I am aware on a sufficiently large scale and at sufficiently great distances to settle this point, and the experimental problem is undoubtedly complicated by the effect of the nature of the soil surface over which the waves travel in different dielectrics or regions. Nevertheless, Mr. Marconi's experiments show that the directivity persists for several hundred miles. Recently the problem has been discussed by H. von Hoerschelmann. According to his theory, the effect of a bent antenna is entirely due to vertical electric currents which are produced in the earth just under the horizontal part of the bent antenna. Hence the directivity depends on the conductivity of that region of the earth. He points out that as a consequence of his theory a bent antenna situated over a sea surface should not have the same degree of directivity as one situated over a poor conducting soil. These conclusions could easily be checked experimentally.

The general result of all the theoretical investigations of Zenneck, Sommerfeld and Hoerschelmann is to show that the function of the earth in radiotelegraphy is by no means confined merely to guiding a space wave, but that it fulfils a most important function in assisting to create surface waves and in permitting earth currents which have directive effect. Recent experiments with antennæ laid on the ground or under the ground by Dr. Kiebitz have turned attention afresh to the matter, although many of Kiebitz's results seem only a repetition of those obtained by Marconi in 1906 with antennæ laid on the ground or a little above it.

Kiebitz used as receiving antennæ wires carried on insulators placed in ditches about 1 metre deep. The ends of the wires were earthed through condensers. The receiving appliance was at the centre. By such antennæ properly oriented he found he could receive signals from all the principal radiotelegraphic stations in England, France, and America.

There is no need to assume that these received waves are propagated through the deep strata of the earth. The effects are exactly what might be expected from waves travelling over the surface.

The chief interest of Kiebetz's experiments lies in the confirmatory proof they give that an elevated antenna is not necessary for *reception*. On the other hand, for long-distance *transmission* an elevated aerial wire or one raised above the earth is requisite.

The chief problem yet to be faced in connection with sending antennæ is to find a form of antenna which will radiate a large power, say, 100 to 500 KW., at a relatively low frequency or long wave length consistently with high antenna efficiency.

There is room for an immense amount of research yet on improved forms of antenna. When we consider that the function of a sending antenna is something like that of a gas mantle or gas-fire radiator, viz., to transform into radiation of desired wave length as large a fraction as possible of the supplied energy, and remember what has been done in the corresponding luminous problem, it is easy to see that countless questions of great practical value in connection with antennæ for radiotelegraphy remain unsolved.

The ingenious methods of directive telegraphy due to Bellini and Tosi deserve mention, and suggest that, in the case of wireless plant erected on ships, means for instantly locating the direction of the arriving waves is a matter of the greatest importance. Although the practical problem is to some extent solved, there is abundant room for further invention in connection with it.

We can hardly leave this discussion without some mention of the state and prospects of wireless telephony.

The essential condition of success in transmitting speech is the possession of means for creating undamped oscillations or alternating currents with a frequency not less than 20,000. When the Poulsen arc generator was first introduced it was hailed as a solution of the problem, but practical experience has shown that it has not the simplicity and ease of manipulation required for commercial work. The modification recently introduced by Mr. E. L. Chaffee consisting of a copper-aluminium arc in damp hydrogen, the arc being formed between two closely adjacent plane surfaces, appears to be an improvement. The practical solution seems, however, to be in the perfecting of some simple easily-managed form of high-frequency alternator. The ingenious inventions of Goldschmidt in utilising

the properties of the polyphase motor to increase frequency have been developed by the Lorentz Company of Berlin, and seem likely to result in the production of a practical form of extra-high-frequency alternator.

In addition to the generator, inventors have wrestled with the difficulties of making a microphone transmitter which shall be able to carry a large current without heating. To conduct wireless telephony over any distance we have to modulate in accordance with the wave form of the speaking voice a very large antenna current. The problem has to some extent received solution in the liquid microphone of Majorana, the relay microphone of Dubilier, and a recently invented heavy current microphone of Rühmer. Wireless telephony is therefore even now a practical matter for a few hundred miles of distance. It is quite within possibility that it may yet be conducted across the Atlantic.

As regards other inventions, we are still in want of more simple means for recording telegraphic messages. Since the coherer fell out of use the reception has been mostly conducted by ear. Somewhat elaborate photographic methods, suitable for large land stations which employ the Einthoven string galvanometer, have been introduced, but what is still required is a means of calling up the operator and of recording the message on board ship, which is at least as sensitive as the telephone plus the human ear, for ordinary shipboard communication.

The receiver current is, however, very small and the available power is at most a few microwatts in the form of a current of a few microamperes.

There are, therefore, innumerable practical and scientific problems in connection with radiotelegraphy which await solution. These require mathematical, physical, and radiotelegraphic knowledge of a high order to overcome them.

CAPTAIN H. RIALL SANKEY said his first duty was to apologise for the absence of Mr. Marconi, who fully intended to be there that day, but at the last moment was called to the Continent.

The questions up to No. 17 were more or less mathematical and theoretical, and he could not say much about them. He would point out, however, that theories must be based on experiments, and that no doubt was what Dr. Fleming had in his mind when he suggested a committee. The Marconi company at the present moment were carrying out a great number of experiments on long-distance transmission in all sorts of conditions, in different parts of the world and in different directions. There was a great difference between the ease of transmission north and south or south and north, and east and west or west and east. No doubt the daylight had something to do with it. Many of these questions were still obscure, but they hoped by those experiments to be shortly furnished with data which might furnish the answers to some of them. Isolated results were really of little use. It was the combination of experiments which would yield the results wanted. As regards the tuning of wave lengths, which was one of the methods of removing interference, this was by no means the only way. There was tuning by means of a musical note. The spark gap was so arranged as to give a certain number of signals per second ; 500 was the middle A on the piano, and it gave that particular note in the telephone. The pitch had been worked up to 1,000, but it appeared that although that note penetrated better than the lower notes, it produced a disagreeable sensation in the ear of the observer. Quite recently a new arrangement had been adopted of erecting the aerials. One was placed at right angles to the other, and in this way interference was reduced. They could also get duplex transmission. There was also another method. Suppose three signals were being received ; they wanted to hear one of them and do away with the other two. There was an arrangement by which the two signals they did not want to hear could be opposed and thus annulled. The one they did want to hear was reduced in strength, but it could still be heard. As regarded question No. 19, as to the probability of replacing the telephone, within the last few months a photographic arrangement had been evolved which could work up to 50 words a minute. But within the past few days a new arrangement (of which he was not at liberty to give details) had been devised which they believed would do away with the photographic arrangement. There was one great objection to these recording systems. They simply recorded everything, both the signals they wanted to hear and the signals they did not want to hear ; whereas the human ear could distinguish the signals they wanted to hear, and leave out those they did not want, very much in the same way as a bandmaster could distinguish one instrument when the others were also playing. This new arrangement would record everything, and yet have the advantage of the telephone arrangement and pick out the signals required. With regard to question No. 20, as to a suitable call signal, an arrangement was now being worked out, and was satisfactory, but had not yet been applied at sea. It was being experimented upon at the works. With regard to No. 21, if the Bellini-Tosi system could be read within one or two degrees of accuracy, this was quite as good as could be got from the compass, so that from a practical point of view the last word had been said. As regards the wireless telephone, they had succeeded up to a distance of 300 kilometres, and they did not think they had by any means reached the limit. At the same time, they thought it would be a long time before it came into use. The Committee which it was desired to appoint undoubtedly could do excellent work in many directions ; but it must be borne in mind that there was a great difference between receiving wireless signals and transmitting them. The apparatus for transmitting was simple and could be easily arranged by anyone, whereas the receiving apparatus required considerable knowledge and skill. From a practical point of view, wireless telegraphy up to ranges of 1,000 kilometres was quite easy, and the apparatus for the purpose was standardised. The real difficulties began with distances up to 2,000 kilometres. That was for commercial work—working day and night and without undue repetition. During the day the signals dropped right off, and no doubt this was the reason why great difficulties occurred at 2,000 kilometres. Hence, unless this Committee could command the use of apparatus for long-distance transmission and had practically unlimited capital, they could not hope to obtain data to answer all the questions put by Dr. Fleming. They would require the whole world as a laboratory and must work with all sorts of waves, and then find themselves in conflict with the commercial companies and all the different wireless stations over the world. At the present time, data of the kind required were being collected as far as practicable and would be published.

(To be continued.)

The Production of Electrical Oscillations by Spark-Gaps Immersed in Running Liquids.

By W. H. ECCLES, D.Sc., and A. J. MAKOWER, M.A.

(Section G. Abstract.)

THE commonest method of generating electrical oscillations for the purposes of wireless telegraphy is by the discharge of a condenser through an inductance coil and air-gap in series. When a large amount of energy has to be handled, there is a tendency for a permanent arc to form between the electrodes, and this reduces the efficiency of the apparatus. In the present paper is described a series of experiments designed to determine whether the efficiency can be increased by making the spark occur in a flowing liquid. The liquids employed in the experiments were water and transformer oil. Although the results show that the efficiency attained is only of the same order as that which can be attained by the air-spark, the details of the experiments are of interest, and suggest methods that would be useful in certain contingencies.

The simplest form of discharger worked with consisted of an ebonite tube, through the sides of which the electrodes protruded to form a small spark-gap in the middle of the bore. When water was passed down the tube, very steady oscillatory currents could be obtained with voltages of about 1,000 volts across the gap. When oil was used the voltages had to be of the same order as those employed with air-gaps, in order to obtain the best results, and, at the same time, the gaps had to be smaller than air-gaps. Other forms of discharger were made which provided for the spark to take place under great hydrostatic pressures, but these showed no consistent electrical advantage over the dischargers operated with liquids at atmospheric pressure. In the paper damping curves are given for various degrees of coupling between the primary and secondary oscillatory circuits. These show that the water spark follows nearly the same laws as an air-spark, and that the spark in oil exhibits the phenomenon known as impact excitation. Dischargers of the type described possess the advantage over the open air-spark that their discharge can be made practically noiseless.

The Impedance of Telephone Receivers as affected by the Motion of their Diaphragms.

By A. E. KENNELLY and G. W. PIERCE.

(Section G. Abstract.)

THE authors describe the results of a series of measurements of resistance, inductance, reactance and impedance, made by them on several telephone receivers of well-known types. The measurements were made over a wide range of alternating-current frequencies (430 to 2,400 cycles per second). The frequency was varied adjustably over this range, as the independent variable, and the measurements obtained were found to vary in dependance on the frequency.

The measuring apparatus consisted of a Rayleigh modification of the Wheatstone bridge. The ratio arms were small non-inductive resistances and were equal. The telephone under test formed a third arm. An adjustable non-inductive resistance in series with an adjustable inductance formed the fourth arm. A pair of head telephones, in the balance wire of the bridge, enabled balance to be adjusted. The source of alternating currents supplied to the bridge was a Vreeland oscillator, which maintained constant voltage at the terminals of the bridge, and, therefore, at the terminals of the telephone under test, at each frequency—the different frequencies being obtained by variation of the electrical constants of the primary oscillating circuit of the Vreeland apparatus. The E.M.F. impressed on the bridge in this way was very nearly sinusoidal, and, at the telephone terminals, varied, in different series of tests, from 0·3 to 1·0 volt.

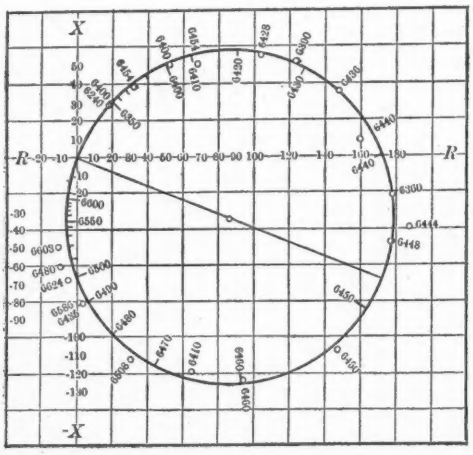
It was found that the resistance, inductance and impedance of a telephone receiver, measured in the above manner, differed when the receiver diaphragm was free to vibrate, from the values obtained when the diaphragm was damped, or arrested, say, by pressing the finger on the centre. The values with the diaphragm free, differed very markedly from the values with the diaphragm damped, when the frequency impressed on the bridge was at or near the natural fundamental frequency of the diaphragm. In other words, when the impressed frequency was much above or below the

natural vibration frequency of the diaphragm, the difference between the "free" and "damped" resistance, inductance or impedance of the receiver was relatively small; but when the impressed frequency was brought into consonance with the natural vibration frequency of the diaphragm, the latter was thrown into powerful vibration, emitting a loud sound, and the E.M.F., induced by the vibrating diaphragm in the coils of the receiver, caused the free resistance, inductance and impedance to differ markedly from the corresponding damped values. The damped values were thus the true values with the diaphragm inert, and the free values were the values as apparently altered by the E.M.F. induced in the receiver, regarded as an alternating-current motor of the reciprocating type.

Considering first the damped values, it was found, as was already well known, that the resistance of any receiver increased with the frequency, while the inductance diminished. The results obtained on the instruments measured showed, what was apparently new, that the product of the resistance and the inductance remained substantially constant over a wide range of impressed frequency, or that the resistance was inversely proportional to the inductance. Moreover, it was found that the resistance was very closely a quadratic function of the frequency, containing, therefore, a constant term—the resistance to continuous currents—plus a term proportional to the frequency, plus a term proportional to the square of the frequency.

Considering the free values, it was found that whereas the damped impedance of a receiver was a vector magnitude, which, when plotted to resistance abscissæ and reactance ordinates, moved over a nearly straight line as the frequency was increased, the free impedance, on the contrary, moved around a loop, so that, at the neck of the loop, one and the same free impedance corresponded to two widely different impressed frequencies. In other words, whereas the damped impedance of a receiver is a steadily advancing single-valued vector, the free impedance is a vector that runs around a loop at a certain place in its general line of advance, so as to present one double value of frequency for a single value of impedance. This loop of free impedance embraces the range of frequency at and near the natural vibrational frequency of the diaphragm.

If the damped impedance is subtracted from the free impedance, throughout a series of such measurements at increasing frequencies, the differences are vector quantities, which may be called "*motional impedances*," since they are the changes of vector impedance effected by the motion of the diaphragm, for the particular frequency and terminal voltage considered. It was found that the motional impedances of any receiver, when plotted vectorially for a succession of frequencies, formed a *circular graph* through the origin. That is to say at a very low, or very high, frequency, the motional impedance is substantially nil; but as the frequency advances from the low to the high value, through the natural frequency of the diaphragm, the vector motional impedance traces out a circle in the negative direction, such as that shown in the



accompanying figure, which gives the motional impedance for a certain experimental monopolar telephone receiver. Here, — R R is the axis of "motional resistance," or difference between free and damped resistance, — X X is the axis of "motional reactance" or difference between free and damped reactance. The small circles in the diagram are points of observation, and the numbers attached to them are the corresponding "angular velocities," sometimes called "pulsations," which are 2π times the corresponding frequencies. The circle is seen to pass very fairly through the observed points. The radial strokes and attached numbers, lying along the inner rim of the circle, are computed values, arranged for reference.

The first approximation theory of the phenomenon has been duly worked out by the writers. It shows that such a circular graph of motional impedance is to be expected with change of impressed frequency at constant impressed voltage. It shows, moreover, that the frequency at the free end of the principal diameter of the circle is the frequency of resonance, or the natural fundamental frequency of the diaphragm. In the case represented by the figure, this resonant frequency was $6{,}449/2\pi = 1{,}026{\cdot}4$ cycles per second, at which the motional resistance was + 172 ohms, the motional reactance — 67 ohms, and the motional impedance 180 $\angle 21{\cdot}5°$, or 180 ohms dipping 21·5°. This frequency of 1,026·4 cycles per second is, therefore, the natural frequency of the diaphragm. The angle of dip, 21½°, is computed to be twice the angle of lag of the magnetic flux behind the alternating current in the coils.

It is shown in the paper that the "damping coefficient' of the receiver diaphragm can also be obtained from an inspection of the circular graph. In the case presented by the figure, the logarithmic decrement of the damping is found to be approximately 20; so that the diaphragm, if set in independent vibration, would allow its amplitude of vibration to fall to $1/e$, or to 36·8 per cent., in $\frac{1}{20}$th of 1 second. The circular graph of motional impedance is thus shown to be an index of important mechanical and electrical constants for any receiver. The diameter of the circular graph does not vary rapidly with the value of the impressed terminal voltage, as far as the measurements have shown; but it varies greatly for different receivers. It was greatest in the measurements reported for the case presented in the figure. In very weak receivers, the motional impedance becomes so small as to be barely perceptible.

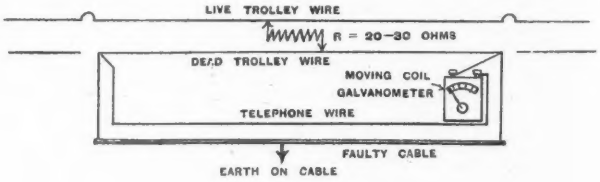
CORRESPONDENCE.

Letters received by us after 5 P.M. ON TUESDAY *cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.*

Fault Finding.

I note in the current issue of the ELECTRICAL REVIEW an article on fault finding, in which mention is made of the use of one trolley wire as a temporary conductor to complete the "bridge."

I have devised a method similar to the above, in which all calculations are eliminated. In the case of an earth on a traction feeder, use is made of the trolley wire nearest the footpath, all cars using the other wire during operations.



The trolley wire, feeder, and a telephone wire are connected as per sketch above, and the moving coil portion of a D.C. ammeter, or voltmeter, is connected across the ends of the system, as shown.

The resistance R is carried on top of the tower wagon, and the ends are placed in contact with the live and dead trolley wires; the resulting current of, say, 20 amperes, divides, part flowing each way to reach the earth. The point of no deflection of the galvanometer is directly over the fault, as will be seen by comparing the connections with those of a slide wire bridge with the trolley wire as the slide wire.

If the fault is near the ends the mean of two positions is required, one with the galvanometer across the trolley wire, and the other with the galvanometer across the faulty cable ends.

In the case of a fault on a lighting main a length of ordinary bell wire is run exactly over the main, and a second length as a galvanometer connection in place of the trolley wire and telephone wire respectively. Current is led from a live main through a resistance to various points along the bell wire, and the point of no deflection is directly over the fault. I have found both methods very accurate in actual practice.

W. Redmayne.

Rotherham, *September 2nd*, 1912.

A Curious Coincidence.

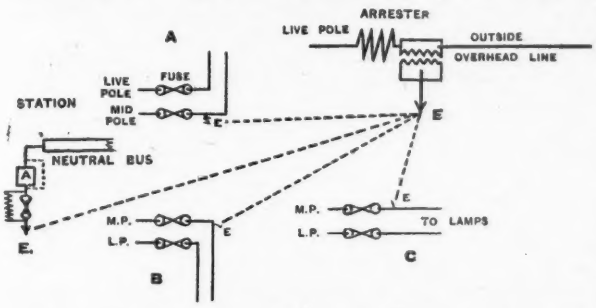
A little comment on the accompanying sketches will, I think, lead to a satisfactory explanation of the phenomenon under mention. The overhead line, of which a portion in proximity to the lightning arrester is shown, is assumed to be situated *somewhere* on the supply system, and is, say, rather

heavily fused, or is protected by a circuit-breaker set fairly high.

A lightning flash discharges itself by way of this overhead line, and in traversing the comparatively small arrester air-gap to earth, establishes an arc which is maintained by the supply after the discharge has spent itself, and develops possibly into a heavy "earth"; assume it does.

A, B and C are consumers who have leaks on the neutrals of their installations, which, under ordinary circumstances, may pass unnoticed; apply this to the cases in question, since no leaks appear to have been recorded prior to the disturbance.

The heavy earth-current has, therefore, four passages available to, or from, the station, shown, for the sake of illustration, by straight dotted lines; or, looking at the



matter from a somewhat different standpoint, the fact of a live pole being brought temporarily to near earth-potential, results in the mid-wire now, in all probability, automatically connected to earth through a resistance, becoming alive, or otherwise, shuts down a portion of the supply.

Consequently, any fuses between the neutral-poles and the earth-faults in these installations blow, with the result that the lamps connected thereto may, for the time being, get almost double pressure, burst, and blow the live fuses (depending, of course, on which side of the system they are connected) and the neutral faults be simultaneously burned out.

All this may, and in all probability would, occur independently of the mid-wire earth-panel arrangement at the station, but perhaps to a greater or lesser degree, according to the efficacy and soundness of the system in vogue.

The foregoing also explains the latter portion of "Junior Assistant's" query in reference to the breaking of lamps coincident with a lightning flash.

Any further debate on the question will lead up to a lengthy leak *versus* fuse argument, applicable to certain instances of three-wire distribution, incidentally of interest to the writer.

One thing more may be noted: in the event of any neutral fuses having blown without removing the faults, the lamps will, provided they and the live fuses are sound, continue to light to earth after the disturbance has spent itself, and a leak will be apparent at the station.

Mains Superintendent.

Aberdare.

Central Station Appointments.

The following appears in a certain local newspaper:—

The Electricity Committee of the Bridlington Corporation have recommended that a "station" engineer be advertised for at a salary of £160 per annum, and for a "charge" engineer at a salary of £80, rising to £100 per annum. It was explained that it was only intended to make one appointment.

No doubt those who have applied for either or both of these positions will be anxiously awaiting reply, but when one considers that the two invitations might draw 500 applications, it will be consoling to all to know that his (supposed) chance will work out at 1 : 500.

The idea seems to be to (1) advertise the undertaking; (2) secure applications from all classes now in receipt of any salary below, say, £150; then (3) probably make the one appointment at the magnificent salary of £80 per annum.

The fortunate one will be first assistant. He will have charge of the whole show, repairs, &c., and will have no charge engineer other than himself. Years ago an engine driver received £91 per annum.

In case this appears before the appointment is settled, my advice to those concerned is "beware"; understand the duties before accepting the appointment offered.

Knobstick.

Impregnation of Wooden Poles.

It is somewhat unfortunate that Mr. Manktelow has made no mention of the Powell process in which saccharine matter is absorbed, or digested, into the wood without the use of pressure or vacuum. Sugar being crystalised, sap is an amorphous form of wood, and therefore a much more suitable material than creosote and other mineral matters.

This process has been a great success in Australia, and with its aid the white ant difficulty is practically overcome. The mention of the electric seasoning experiment in Melbourne is interesting, but to refer to that and not mention the large works at Sydney and West Australia where the Powellising process has been carried on for the last six years is a grave omission.

E. Kilburn Scott.

Bromley, Kent, *September 6th*, 1912.

Earthing in Collieries.

I note the reference in your issue of August 30th, to the action brought by Mr. Atkinson, representing the Home Office, against Mr. Imrie, the manager of the Consett Iron Co., and I venture to think that if you had had all the facts before you, your criticisms would probably have been less severe.

There is no doubt that the members of the Advisory Committee, and also the majority, at any rate, of the coal owners in the United Kingdom, believe that the Exemption Clause, which was obtained after considerable discussion, is a clear exemption in connection with installations erected prior to June 1st, 1911, assuming that such installations complied with the requirements of the old Rules.

A great deal of doubt still exists in the minds of not only electrical men, but also mining engineers, as to the advantages of armoured cables, and also earthing as called for by the new Rules, and I note in your last issue a letter from Mr. Sydney F. Walker on this subject; I am not at all sure myself that the method of earthing prescribed or recommended by the Home Office is one which can be adopted in all cases, as those acquainted with the installation of electricity in mines are well aware that there are insulating strata, and the existence of such would render earthing to one point on the surface of no avail.

There is no doubt that for mechanical protection the armouring of cables is of considerable value, but one has to consider the risk of corrosion, and if the armouring is used for earthing purposes, the whole earthing system becomes one requiring the greatest skill and attention in erection, and also requires constant attention if it is to be relied upon as a safeguard; at the same time, I believe that such a system properly looked after combines mechanical protection and efficient electrical safeguard.

In your article one would gather that the Consett Iron Co. were neglectful of the lives or safety of their workpeople, and that this accident occurred because they, as a company, wished to shelter themselves under the Exemption Clause and avoid the expense of meeting the requirements of the new Rules. Such, however, is far from being the truth, as the Consett Iron Co. had in this particular installation adopted armoured cables throughout, and in five of the conveyors out of seven they had already introduced earthing arrangements constructed and adapted to the requirements of the new Rules, and the other two conveyors would have been altered except for the coal strike, which prevented them completing the work, and I feel sure that your well-known desire for fairness will prompt you to give prominence to this statement.

Speaking as the representative of the coal trade, not only in the position which I held as electrical expert to the Mining Association of Great Britain, but also as a member of the Advisory Committee for Northumberland on both inquiries, I can honestly state that there is no body of men more anxious for the safety of their workpeople than the colliery owners, managers and officials, but one must bear in mind that whilst any reasonable expense is not objected

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to, there is a limit; it might interest you to know that in the recent inquiry I took out the cost of bringing 11 installations in the Midlands, all of which had been erected in accordance with the old Rules, up to the requirements of the new Rules, and I found that the expenditure was £49,000, and in not one of these collieries had there been an electrical accident, fatal or otherwise, during the whole period the installations had been running.

As you state, this case is *sub judice*, so that beyond a mere statement of what I know to be the facts of the case, we cannot enter into its merits, and I thank you very much for the opportunity of replying to your leading article on this subject.

W. C. Mountain.

Newcastle-on-Tyne, *September 9th*, 1912.

[We are pleased to publish this letter, which throws a good deal of light on the subject. The deduction is obvious that, although the Consett Iron Co. asserted its claim to exemption from the requirements of the new Rules, it was taking active steps to comply with them. We have pleasure in recording the fact, which was not brought out in the report received by us—otherwise our criticism, as Mr. Mountain suggests, would certainly have been milder. We trust that the company's praiseworthy example is being followed by other colliery proprietors, without regard to the question of exemption.—Eds. E.R.]

Municipal (?) Trading.—We regret to say that the writer of the letter published under this heading in our last issue proves, on inquiry, to have given a false name and address. Mr. J. E. Schofield, commercial assistant to the Bradford Corporation, of course, was not the writer: on the contrary, he appears to have been the person aimed at, and we are sorry that by this despicable trick he has been subjected to a cowardly attack.—Eds. E.R.

ELECTRICAL EXHIBITION AT NEWCASTLE-ON-TYNE.

The second North-Eastern Counties Electrical Exhibition was opened in the Exhibition Hall, St. Mary's Place, Newcastle-on-Tyne, on Saturday, the 7th inst., and will be continued until the 28th inst.

The present Exhibition differs from the first in one broad principle: the first was primarily to illustrate the advances in the application of electricity as a mode of power in connection with manufactories, works, railways, collieries, &c., while the chief aim (although by no means the sole object) of the present exhibition is to bring home to the general public the enormous development in the application of electricity for domestic purposes, and to demonstrate the great variety of uses to which it can be put. The value of the invention of the metal-filament lamp and the reduction that it has effected in the cost of lighting: and the comparative perfection of the methods of heating and cooking are shown in a hundred different forms, at once attractive and useful.

The advisory board of the Exhibition is constituted of the following: Messrs. A. S. Blackman (borough electrical engineer, Sunderland); C. S. Vesey Brown (chairman, Newcastle Section, Institution of Electrical Engineers); L. E. Buckell (Newcastle Electric Supply Co., Ltd.); H. W. Clothier (hon. sec., Newcastle Section, I.E.E.); W. Cross (vice-chairman, Newcastle Section, I.E.E); Harry S. Ellis (borough electrical engineer, South Shields); C. W. Fairweather; W. Fletcher (secretary, Newcastle branch, Electrical Contractors' Association Incorporated); T. J. Grainger; A. B. Gridley (Cleveland and Durham Electric Power, Ltd.); W. D. Hunter (Newcastle and District Electric Lighting Co., Ltd.); Ernest Hatton (general manager, Newcastle Corporation Tramways); Chas. H. Merz; J. W. Morley (Electric and Ordnance Accessories, Ltd.); W. C. Mountain; J. Pigg (electrical superintendent, North-Eastern Railway); J. M. Robb (superintendent, Electric Telegraphs, G.P.O., Newcastle); Allan Robson (Simplex Conduits, Ltd.); Robert Robson (Chairman, Newcastle branch, Electrical Contractors' Association Incorporated); Herbert Shaw (secretary, Newcastle Chamber of Commerce); R. P. Sloan (Newcastle Electric Supply Co.); H. M. Taylor (borough electrical engineer, Middlesbrough); Prof. W. M. Thornton (Armstrong College), and C. Turnbull (borough electrical engineer, Tynemouth).

Under the ægis of this board a highly interesting exhibition has been arranged, each item of which helps to ensure that all the different uses to which electricity can be put in lightening domestic labour, in reducing expense, and promoting health in home life shall be demonstrated under actual working conditions. The utilisation of electricity as a mode of illumination is now well established; but in the matter of cooking the same cannot be said, at all events, to the same extent. The position in regard to cooking has been materially altered as a result of the cheap production of energy and the immensely enhanced efficiency of the cooking apparatus. This is shown by demonstrations of cooking twice or thrice daily. In this connection, also, are shown the most modern forms of ovens, grills, saucepans, frying pans, kettles, &c. But the domestic section extends beyond this, and includes potato-peeling machines, washing machines, mangles, irons, sewing machines, &c. To heating by means of the electric current much attention has been given to make the exhibits thoroughly representative and convincing, and the luminous lamp radiator and the semi-luminous quartz type radiators and convectors are shown in actual use. Lighting, most naturally and properly, has devoted to it much space, and all forms of lamp are shown, as well as indirect lighting.

In addition to the domestic side of the Exhibition, there are many stands of a different, but not less attractive, character. Amongst these are the Ozonair apparatus, switchboards, cables, brazing hearths, water heaters, storage batteries, electrical testing and measuring instruments, signs and radiators, suction cleaners, portable batteries, carbon dynamo and motor brushes, electric impulse clocks, &c. A system of electrical cab signalling for railways, as devised by Mr. Raven, of the North-Eastern Railway, is shown by a working model, and another very attractive display is that by the Marconi Wireless Telegraph Co., Ltd. The latter exhibit consists of two Marconi wireless telegraph ship plants, one of the standard ½-kw. pattern, suitable for cargo steamers or liners, where long ranges are not so necessary as on the large liners; the other of the induction-coil pattern, suitable for lightships or fishing smacks, where even a shorter range is required. The cargo ship set is divided into two parts; the transmitting plant is mounted in a silence cabinet, and the receiving and operating apparatus is mounted on an operating table. The ½-kw. cargo set is a small power installation designed to produce transmitting waves of 250 and 600 metres, or any intermediate wave length with a simple change over from one to any other. The working range depends on the height, length and shape of the aerial. The receiving apparatus provides for tuned reception of all waves between 250 and 1,600 metres. The working receiving range is also dependent on the aerial. This exhibit is intended to bring home to the carge ship-owner the ease and economy with which the invaluable wireless system can be adapted to his purposes, and the appeal in a district like Tyneside, where so many vessels are built and owned, should not prove unavailing.

The formal opening took place in the presence of a large company, over which Mr. J. Pigg presided.

The Chairman, in introducing the Deputy Lord Mayor (Councillor Herbert Shaw) to open the Exhibition, said they hoped that the success of the opening pressaged the success of the undertaking in spreading a wider knowledge of the adaptation of electricity in the service of the public.

The Deputy Lord Mayor said it was undoubtedly a very important exhibition, and it would stand out in the annals of electricity, especially from the point of view of domestic economy. Whilst it was true there had been larger electrical exhibitions in various parts of the country, he believed he was correct in saying that that was the largest one applied to domestic economy that had ever been held in the United Kingdom. The Exhibition was intended to promote a knowledge of electricity as applied to the home, and if one of the results of the venture was to save a great deal of time

and worry by the extended use of electrical appliances, then it would have done a great deal of good and would have earned the gratitude of many householders.

Votes of thanks to the Deputy Lord Mayor terminated the formal proceedings.

The following is a list of the electrical exhibitors taken in the order of the stands; we shall deal with some of the exhibits in a later issue :—

Robert Bowran & Co., Ltd., Newcastle. (Electric propeller fans, Ozonair apparatus, wires, cables, &c.)

Marconi's Wireless Telegraph Co., Ltd., London. (Ship installations.)

Newcastle Electric Supply Co., Ltd. (Cooking demonstration stand.)

C. S. Vesey Brown, Newcastle. (Electric water heater.)

Provincial Laundries, Newcastle. Electrical laundry in operation.)

Electrical cab-signalling on railways (patented by Mr. Vincent L. Raven, chief mechanical engineer, North-Eastern Railway Co.)

Scholey & Co., London. (Domestic and industrial applications of electricity.)

Simplex Conduits, Ltd., Birmingham. (Appliances for domestic purposes—kettles, irons, grills, toasters, &c.)

Chloride Electrical Storage Co., Manchester. (Storage batteries for lighting, power and traction.)

Johnson & Phillips, Newcastle and Charlton, Kent. (Electric cooking apparatus, radiators and convectors, lamps.)

F. T. Hanks, Newcastle. (Electrical testing and measuring instruments.)

The Herbert Frood Co., Ltd., Chapel-en-le-Frith. (Ferodo for brakes and clutches.)

Edward Weatherley, Newcastle. (Reflecta electric signs.)

Newcastle Retail Exhibitors' combined stand (including Messrs. R. W. Cairns; Falconar, Cross & Co.; Fletcher Bros.; S. Gillitt: Reid, Ferens & Co.; Robson & Coleman; Thos. G. Usher & Co.). Electric measuring instruments, medical apparatus, switches, electric fans, signs, lamps, cooking apparatus, clocks, &c.

Veritys, Ltd., Newcastle branch. (Aston cooking and heating apparatus, signs and radiators.)

Carnegie & Co., Ltd., Newcastle. (Designs for decorating bazaars and ball-rooms, heated and lighted electrically.)

British Electrical Manufacturers' combined stand. (Arranged by the Adnil Electric Co., Ltd.; British Westinghouse Electric and Manufacturing Co.; British Electric Transformer Co., Ltd.; the Dowsing Radiant Heat Co., Ltd.; Electric and Ordnance Accessories Co., Ltd.; Efesca Electrical Works; Ferranti, Ltd.; The General Electric Co., Ltd.; Siemens Bros. Dynamo Works, Ltd.). Laundry appliances, radiators, medical appliances, lamps, heating and cooking, hot plates, signs, &c.

Magic Appliances, Ltd., London. (Vacuum cleaner.)

Pokorni & Co., Newcastle. (Tobacconist's shop window as a specimen of electric lighting.)

Edison Storage Traction Co., London. (Electric vehicles.)

British Vacuum Cleaner Co., Ltd., London. (Cleaners—Booth's patents.)

Newcastle-on-Tyne Electric Supply Co., Ltd. (Electric nursery, drawing room and lounge; cooking devices.)

The Float Electric Co., Ltd. (Portable batteries and lamps.)

Le Carbone, London. (Carbon dynamo and motor brushes.)

G. Edward Carr, Newcastle. (Current transformers, compensators, armatures.)

Gent & Co., Ltd., Newcastle. (Electric impulse clocks.)

THE HARDWARE AND OIL ENGINEERING EXHIBITION AT OLYMPIA.

THIS Exhibition, the first of its kind, was opened on September 7th, and remains open until the 17th. The chief exhibits were well-drilling plants of various types in the form of models showing the machinery for drilling with ropes as so usual in America, or with light rods as in the Canadian system, as distinguished from the stiff square rods of the English system. As in other matters, each country has developed its drilling methods to suit its own conditions.

The steam or power user will be interested in the numerous samples of oil shown by the Petroleum Institute and others, and the instrument maker will examine with interest the Holland Drilling Co.'s exhibit of a compass for taking the dip direction of the strata pierced as well as the angle and direction of the deflection of a borehole from the vertical by means of a compass needle which can be released or clamped from the surface, and a pendulum. The same company also show a clockwork recorder which shows graphically the rate and depth of boring in any period of hours. They also show a compound core drill for soft strata so arranged that soft and friable cores are protected in a closed core barrel from the action of the wash water.

Oil engines are shown by the Westinghouse Brake Co., Ltd., Blackstone & Co., Ltd., Tangyes, Ltd., Crossley and Co., Ltd., and others.

It is disappointing to find no exhibit of oil-burning appliances by way of furnaces, firebricks, atomisers, pumps or anything to interest the electrical engineer who may be considering the question of oil fuel in relation to its use for surmounting sudden fog demands. In the exhibition which, we believe, it is intended to hold next year, we would suggest that a furnace should be equipped so that different systems of atomisation could be shown in operation in turn. This could be very simply arranged by the provision of an oil, an air and a steam pipe, every exhibitor furnishing his apparatus ready to be connected to these terminals and his own door to fit the furnace, of which each intending exhibitor would have supplied him a fully dimensioned drawing. We feel sure such an exhibit would attract and would be educational and effective. No Diesel engine was shown, which is also to be regretted, for the future of oil fuel seems likely to be as closely allied with the engines to burn liquid fuel as with furnaces for steam raising. The tendency of the day is towards direct applications rather than towards the methods of the steam engine.

Though outside the oil range, a very excellent exhibit is shown by the British Oxygen Co. in the shape of their oxygen cutting-flame. This is a development of the oxy-acetylene welding blowpipe. There is the usual blowpipe jet of oxygen and acetylene mixing the gases near the point of combustion, but in the centre of this annular flame a fine jet of oxygen is passed into the heart of the heating flame and plays upon the metal, which is heated by the blowpipe outer flame. The metal, iron or steel, rapidly oxidises, and the oxide is blown away by the oxygen jet, and armour plates as much as 12 in. in thickness can be cut through at the rate of 13 linear ft. per hour, using 50 cb. ft. of oxygen per ft. run of cut, and about 5 cb. ft. of acetylene for thick cuts. For 1-in. plates about 2·2 cb. ft. of oxygen are consumed per ft. run. The rate is about 40 linear ft. per hour, and the consumption of acetylene about a fourth the volume of oxygen. With coal gas the volumes of gas are double the volumes of acetylene, and coal gas is considered more suitable for light work.

On Stand Nos. 101 and 102, a selection is shown of the Ozonair Co.'s apparatus. Ozone, owing to its adoption on the Central London Railway and in many important public buildings, has come to be generally known as a great aid to ventilation, purifying and freshening the air; it is also employed for the purification and sterilisation of drinking-water supplies, whilst its industrial applications are very numerous. Ozone is now being employed in various therapeutical applications, and is prescribed for consumptive patients who have to reside in towns instead of in the open air of the country.

The apparatus exhibited are examples of the principal portable types of ozone generators made by the company. An important feature of it is that, in producing ozone, no nitrous oxides are formed, and consequently there is no liability to harmful effects. Small machines are also exhibited, adapted for fixing permanently on to the wall, and larger apparatus is also on view. A full-sized plant is shown in operation, as used in the ventilation of large buildings. Messrs. Ozonair, Ltd., have now installed several hundreds of such ventilation plants, which both purify and filter the air, heat or cool it as required, and charge it with a proper proportion of ozone.

The exhibit of the India-Rubber, Gutta-Percha & Telegraph Co., Ltd. (the Silvertown Co.), of Silvertown, London, E., includes one Silvertown-Crossley oil-engine set (the dynamo being a standard Silvertown machine of 5·5 KW.) and two Silvertown petrol or paraffin-electric sets. All three sets are specially designed for private house, hotel and ship lighting and power. In addition, there are a three-wire dynamo of 25 KW., 460-480 volts, a high-speed revolution counter, a ceiling fan, various small motors, and a hose of special construction for use with petroleum, all of Silvertown make.

The Silvertown patent electrically-controlled revolution counter is designed to count with perfect accuracy the revolutions of a shaft in a given time, and is suitable for speeds as high as 8,000 R.P.M. It is controlled by a clock-driven electric contact, and an arrangement is provided for re-setting the pointers at zero for each reading.

Barnet Lighting.—Owing to the bad lighting of the district by the Gas Co., Councillor Ford has intimated his intention of moving at the next Council meeting, that the Council at once approach the North Metropolitan Electric Power Co., asking if it will be possible for it to lay mains throughout the district by October, 1913, and, if so, at what cost it would light the roads.

LEGAL.

SALE OF PRIMARY CELLS.

IN the City of London Court, on Friday, Mr. Frederick Hodgson, 24, Queen Street, E.C., electrician, sued Mr. William Box, 39, Windmill Road, Gillingham, Kent, for £16 14s. 10d., being 15 guineas damages for breach of contract and 9s. 10d. for carriage. His case was that defendant offered him 280 primary cells at 1s. 1½d. each, saying that they were quite new. Plaintiff paid for them in advance at defendant's request, and then found that many had been used before, as the batteries had salammoniac in them, and others were not equal to sample submitted. The majority were practically useless. Defendant said that was not true; the cells were quite good and not defective. He did not sell by sample. He bought them from the Government, as they came from the Royal Military Engineering School, Chatham. He paid nine guineas for them, and their original cost to the Government was 5s. each or £70. Could plaintiff expect absolutely perfect goods for 1s. 1½d. each? Judge Rentoul inspected all the cells, and said some of them were good, but not many. He did not think the authorities knew their condition, and the Government might meet the defendant. He must find for the plaintiff, but it would be without costs.

A SCOTTISH CASE.

THE record has been closed, in the Dunfermline Sheriff Court, in an action at the instance of John McDonald, farmer, Invernessshire, against Messrs. Balfour, Beaty & Co., tramway contractors, Dunfermline, in respect of the death of his son Alexander, who was employed as a plumber by the defendants.

The pursuer sues for £500 at common law, or, alternatively, £236 under the Employers' Liability Act.

The deceased was electrocuted on December 14th last at the East Wemyss sub-station through touching an exposed portion of a cable which was being tested. The pursuer avers that the cable ought to have been protected by a fence. The defenders state that there was no need for a fence, and that the deceased had no need to be near the cable, or to interfere with it in any way.

NEW ELECTRICAL DEVICES, FITTINGS AND PLANT.

Large Simplex Toaster.

The accompanying illustration, fig. 1, shows an interesting piece of electrically heated apparatus, which MESSRS. SIMPLEX CONDUITS, LTD., of 116, Charing Cross Road, W.C., have just supplied to a large

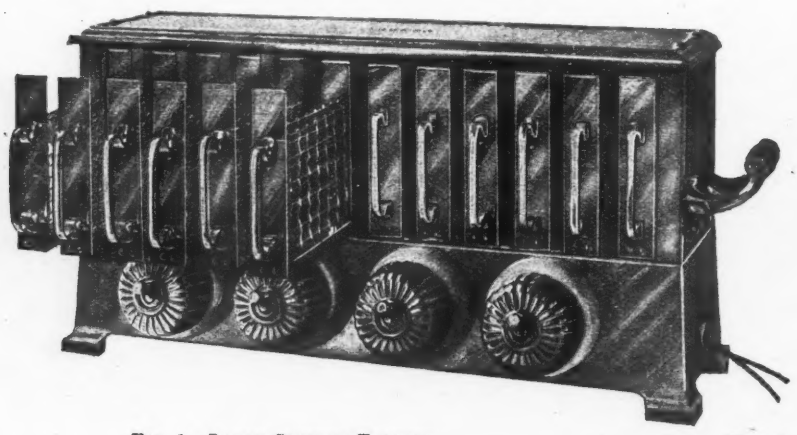


FIG. 1.—LARGE SIMPLEX TOASTER.

catering establishment. It represents a cast-iron nickel-plated toaster, capable of producing 720 full sized slices of toast per hour; the loading is 6 KW., controlled in four sections.

The Simplex Wedge Continuity System.

MESSRS. SIMPLEX CONDUITS, LTD., have also introduced a simple patented device to enable Simplex unscrewed conduits to comply with regulations as to earthing and continuity where such are called for, without any extra charge. It consists of a short T section piece of aluminium or other suitable material, with the upper part curved slightly so as to fit the surface of the tube closely. All fittings for use on the system have a narrow saw-cut in each outlet, into which the wedge is placed, so that the curved top is inside the fitting. The wedge is made of light-gauge metal so that it is possible to insert the conduit without filing, an exceedingly tight fit is obtained, and the action of socketing the conduit compresses the aluminium and gives the conduit a surface of the metal affording an efficient and lasting contact. This scraping effect is increased if the tube be twisted slightly when being inserted into the fitting; the jamming effect produced by the insertion of the wedge, gives a tight

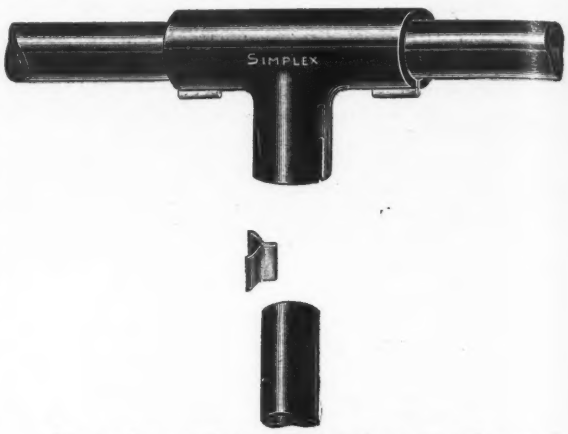


FIG. 2.—SIMPLEX PATENT WEDGE CONTINUITY SYSTEM.

union of considerable mechanical strength. As will be seen from the illustration, fig. 2, there are no unsightly projections, the wedge being hardly noticeable when in position, and the actual operation of inserting it does not occupy an appreciably longer time than erecting ordinary unscrewed conduits.

The "Troika" CO_2 Analyser.

A simple device for measuring the percentage of CO_2 contained in flue gases is the "Troika" analyser, fig. 3, which is being introduced by MESSRS. THERMO AND PRESSURE INSTRUMENTS, LTD., of 60, Salusbury Road, Kilburn, N.W. As shown in the accompanying figure, it consists of a single glass instrument, with two large bulbs and a graduated stem. The lower bulb is filled with absorption liquid, which costs a trifle: one charge suffices for 200 tests. The

FIG. 3.—"TROIKA" CO_2 ANALYSER.

flue gases are passed through the upper bulb and stem with an aspirator while the instrument is immersed in water at atmospheric temperature; the stopcocks are then closed, and a portion of the fluid is shaken up with the gas in the instrument. On opening the upper stopcock while the apparatus is submerged, water enters to take the place of the CO_2 absorbed, and its amount is read off on the graduated scale, which gives at once the percentage of CO_2 contained in the flue gases, without any calculation. The results, it is stated, can be relied upon to 0·5 per cent., and the manipulation is quite simple.

Semi-Indirect Fittings.

THE BRITISH THOMSON-HOUSTON Co. have recently issued a folder dealing with their new line of semi-indirect fittings, by which most of the light is thrown on to the ceiling, and a small portion trans

mitted through the reflector in the form of direct illumination. The fitting consists of a semi-transparent bowl suspended by a brass ring, chains and ceiling plate. The bowl is made of a specially prepared opal glass which gives beautiful lighting effects.

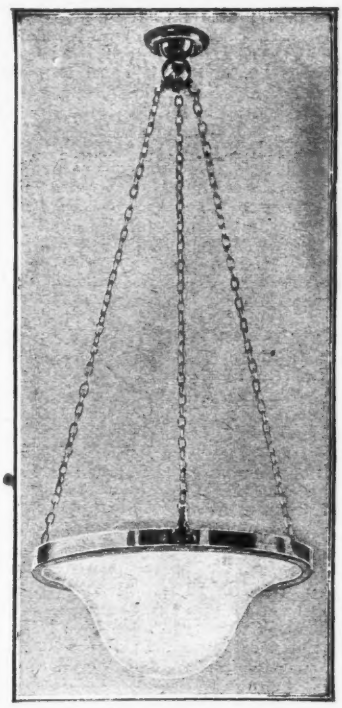


Fig. 4.—B.T.-H. Single-Lamp Fitting for Semi-Indirect Lighting.

These fittings are supplied in two types, one for clusters of lamps up to six in number, and the other for single lamps. Both types are made in several sizes for total lamp wattages ranging from 40 to 600 watts.

Improved Drilling Machines.

Our view, fig. 5, shows four R 5 type drilling machines of the Witton-Kramer type in operation on a large casting at the Witton works of the G.E. Co. In this particular case the inner machines are used for drilling holes $1\frac{9}{32}$ in. in diameter, 8 in. deep, while the outer machines make a counter-bore $5\frac{1}{2}$ in. in diameter, $1\frac{1}{8}$ in. deep. The former operation takes 15 min., while the latter is accomplished in 10 min.

The features of Witton-Kramer drilling machines are their portability and sound construction. The armature as well as the field coils is carefully and thoroughly insulated throughout with

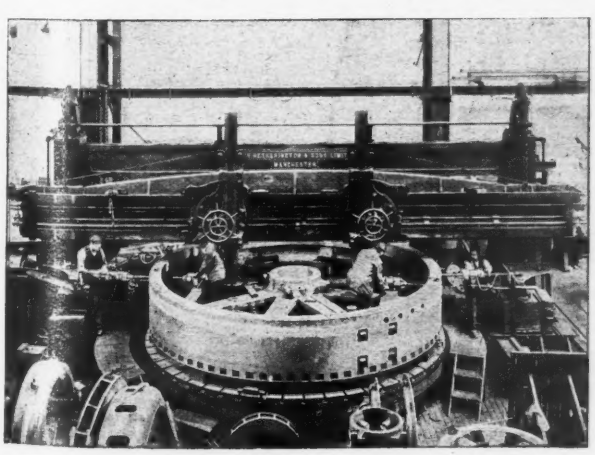


Fig. 5.—Witton-Kramer Drilling Machines in use.

the best materials. Aluminium is used largely to keep the weight of the machine as light as possible, the end shields and switch box being of cast aluminium.

We understand from the General Electric Co., Ltd., that they are prepared to send these machines on approval to *bonâ fide* customers, provided that they pay the freights, and undertake to retain the machines if they are kept any longer than seven days.

In a recent test of the Witton-Kramer drilling machines against German and American machines of similar type, they proved much more satisfactory both in temperature rise after the test had been completed and also in the time taken to do certain boring. The actual figures are as follows:—Diameter of hole $1\frac{1}{4}$ in., depth $2\frac{1}{2}$ in., material, cast-iron, voltage 220 D.C.

The American machine drilled 32 holes, average time 1 min. 45 sec., current consumption 6 amps.

The German machine drilled 23 holes, average time 3 min. per hole, current consumption 4·2/10 amps.

The Witton-Kramer machine drilled 38 holes, average time 1 min. 35 sec. per hole, current consumption 4·5/10 amps.

The fastest time in which the German machine drilled a hole was 2 min., the American machine took $1\frac{1}{2}$ min., and the Witton-Kramer machine 65 sec.

BUSINESS NOTES.

Consular Notes.—Brazil.—The British Consul at Pernambuco reports that that city is regularly visited by a large number of travellers, British and foreign, representing high-class firms and dealing in almost every kind of goods. Competition is very keen, and little is to be done by means of correspondence on the part of exporters at home.

Consular officers receive letters by every mail from British firms asking for the names of responsible agents. Agents as a rule have their own particular lines, and if they are successful, already represent a sufficient number of first-class firms or manufacturers. Beautifully illustrated and elaborate trade catalogues are also constantly being sent out; these are invariably written in English and prices are quoted in English money. To be of any use they should be written in the Portuguese language and prices given in milreis. The metric system should also be used. Occasionally a catalogue in Spanish is received with the prices given in pesetas, which the would-be exporter appears to think will serve equally well, forgetting that in Brazil Spanish is as bad if not worse than English both as regards language and currency. Payments for goods are usually made by bills drawn at 90 days' sight after the delivery of the goods. The best way to open up business and introduce goods on to the Brazilian market is either through one of the large British exporting houses who have their agents on the spot, or with the aid of a first-class traveller who regularly visits Brazilian ports, and who knows the language and people thoroughly. Trading by correspondence or without a representative on the spot usually leads to disputes, unsatisfactory business and bad debts. In doing business with Brazil much depends on the choice of the traveller and on his personality. He should carry a full and carefully selected line of samples, and have a thorough knowledge of his business and the language and customs of the country; in these points it is to be feared foreigners often excel, as one frequently finds foreign travellers successfully representing British manufacturers. The principal imports from the United Kingdom comprise:—Machinery, cutlery and hardware, all classes of cotton textiles, linen goods, drills for suitings, lace, &c.; china, glass, jams, preserves and groceries, thin woollen goods for suits, &c. On the whole, British goods seem to be holding their own fairly well, the most noticeable falling-off being probably found in Manchester goods.

German South-West Africa.—The British Consul at Luderitzbucht reports that telegraphic communication has been established with the Union of South Africa *via* Warmbad Steinkopf. The charge of 3d. per word is made for telegrams from the Union of South Africa to German South-West Africa, while in the reverse direction the charge is 30 pf. (about $3\frac{3}{4}$d.). The Eastern Cable Co. has a station at Swakopmund, which is linked up with the cable between the United Kingdom and South Africa. Wireless stations have been erected at Luderitzbucht and Swakopmund. The latter station began operations in the beginning of February, 1912, and the former was to be ready to send messages on April 1st, 1912. The charge per word is 9d., with a minimum charge of 7s. 6d. per message. The Protectorate can boast of an excellent telephone system, which embraces nearly 50 towns and villages. The town of Luderitzbucht is now lighted by electricity, which is obtained from the electrical works of the Kolonial Mining Co. Swakopmund is also lighted by electricity.

Madeira.—The British Consul at Funchal reports that the installation of telephones under the Government has at last become an established fact. They were erected and ready for use early in October, and by the end of the year some 104 were in working order. There appears to have been some discussion with the Lisbon authorities as to the annual cost, but this point has at last been settled and is fixed at £3 per annum, together with a charge of about £1 5s. for first installations. The system up to the the end of the year was working fairly well, but there were complaints as to the inefficiency of the plant erected; this will no doubt be remedied in the future.

Italy.—The British Consul at Rome reports that one of the causes which in the past has retarded the industrial development of that city has been the want of fuel which had to be imported from a distance, and its price consequently hampered would-be manufacturers. Of late years, however, the water resources of the district have been largely utilised. It is calculated that about 65,000 electric H.P. is at present available for private consumption. The aggregate quantity is 85,000 H.P., of which 70,000 H.P.

is hydro-electric, and the remainder produced by steam. The tramway company uses 6,000 H.P., private consumption 14,000 H.P., leaving over 60,000 H.P. available for general industrial purposes. The advocates of the progress of the Italian capital expect that as soon as conditions will permit it, the Act granting certain fiscal exemptions to new industrial concerns in the Neapolitan districts will be extended to Rome.

The British Vice-Consul at Civitavecchia reports that the contract for lighting the city by electricity, and the supply of electric motive power has been taken over by a new company, and it is stated that fully 2,000 H.P. will be available.

Costa Rica.—The British Consul reports that the hydro-electric power plant of the Costa Rica Electric Light and Traction Co., at El Brazil (5,000 H.P.), was completed during the year 1911, and the power from this source was put into service in December.

Spain.—The British Consul at Seville states that it was reported last year that the monopoly hitherto held by the Compania Sevillana de Electricidad, a Spanish company with German capital, was likely to be invaded by competition. The Sociedad Catalana de Alumbrado por Gas, a powerful Spanish company, till now producers of gas only, have decided to supply electric current for lighting and power purposes. Their work in this direction is making very satisfactory progress.

The British Vice-Consul at Cadiz reports that the wireless telegraph station at Puntales, connected by wire with the telegraph office at Cadiz, was inaugurated in November last, together with those at Barcelona and Santa Cruz de Tenerife. In connection with this service, there will soon be opened other stations at Vigo, Aranjuez, Alicante and Palma de Mallorca. The headquarters of the company—Compania Nacional de Telegrafia sin Hilos—floated in Spain at the initiative of the Marconi Co. with British and Spanish capital, are established at Madrid. The Puntales station has rendered good service by taking over messages during the breakdown of the cable to the Canary Islands. The Eastern Telegraph Co. has submarine cables connecting Cadiz with Gibraltar and Villa Real de San Antonio. The French Government has a cable between Cadiz and Tangier and the Spanish Government one to Tenerife.

Later in his report, the Vice-Consul states :—

Bad debts are by no means so frequent as is commonly supposed, and there are a large number of well-to-do families and very good firms with whom British houses can deal with safety. It is very necessary for the British merchant to guard against wounding the susceptibilities of his clients, since there is no doubt that the unfortunate reputation often undeservedly given to firms in southern Europe renders those whose commercial honour is unassailable particularly sensitive to the treatment frequently meted out to them.

Book Notices.—"The Una-Flow Steam Engine." By Prof. J. Stumpf. Price 10s. 6d. net. "Toll Telephone Practice." By J. B. Thiess and G. A. Joy. Price 14s. net. 1912. London : Constable & Co., Ltd.

"Atti della Associazione Elettrotecnica Italiana." July 31st, 1912. Milan : Stucchi, Ceretti & Co.

"*Bulletin* of the Association des Ingenieurs Electriciens." May, 1912. Liége : The Association. Price 5 fr.

"Handbook of Standard Telephone Construction Methods." By Frank B. Hall, Newton Falls, Ohio, U.S.A. London : S. Rentell and Co. Price 17s. net.

"Science Abstracts." Vol. XV, Part 8. August 26th, 1912. Sections A and B. London : E. & F. N. Spon, Ltd. Price 1s. 6d. net each.

"Examples in Applied Electricity." By C. G. Lamb. 1912. Cambridge : University Press. Price 2s. 6d. net.

"*Proceedings* of the American Society of Civil Engineers." Vol. XXXVIII, No. 6. August, 1912. New York : The Society.

Messrs. Grafton & Co., of 69, Great Russell Street, W.C., are publishing a full-title catalogue arranged under subject headings of all British and American books on engineering, metallurgy and allied topics published during the five years 1907-11, with their English and American prices and publishers' names. The work has been complied by Mr. R. A. Peddie, librarian of the Technical Library of the St. Bride Foundation.

A Charge of Embezzlement.—At Prescot (Lancs.) Petty Sessions, on Tuesday last week, Thomas Hanlon, formerly in the service of the British Insulated and Helsby Cables, Ltd., at the Prescot Works, was committed for trial at the Liverpool Assizes on charges of embezzlement. From the opening statement of Mr. Hutchens, solicitor for the prosecution, it appeared that the defalcations discovered amounted to about £1,000, though the charges were limited to much smaller amounts. When the prisoner went away on his holidays, the deficiencies ceased. When he returned they began again. He gave wrong totals to wages sheets and pocketed the differences, and he entered bonuses to which men were not entitled, and took these too ; and had a clever system of hiding it up. Bail was refused.

Lead Protective Coating for Iron and Steel.—Messrs. Hayward Bros. & Eckstein, Ltd., have been granted a sole licence for coating iron and steel sash bars with lead by the Cowper-Coles process, and a plant is being equipped at their works in London for the purpose.

Liquidation.—District Electric Co., Ltd., Birmingham.—A meeting of creditors will be held on Friday next. Creditors should communicate with Mr. J. W. Hinks, liquidator, 115, Colmore Row, Birmingham.

Private Arrangement.—Fletcher Jackson & Co., Ltd., electrical and mechanical engineers, 89, Halmet Court Road, Westcliff-on-Sea.—Pursuant to the provisions of the Companies' (Consolidation) Act, a meeting of the creditors was held recently at the offices of the company. A meeting of the shareholders had previously been held, when a resolution was passed to the effect that it had been proved that the company could not, by reason of its liabilities, continue its business, and that it was advisable to wind up the concern voluntarily. A further resolution was passed appointing Mr. A. Pensam, of 89, Halmet Court Road Westcliff-on-Sea, to act as the liquidator of the company. A statement of affairs was submitted by Mr. Pensam, which disclosed total liabilities of £1,230. The indebtedness to the trade was only £400, while there was an overdraft at the bank of £30. The balance of the liabilities of £800 represented an amount due on debentures. The assets consisted of stock-in-trade at cost, £400, fixtures and fittings £64, machinery £42, and book debts £400, estimated to realise £350. The assets, therefore, totalled £856, or a deficiency of £374. It was reported that the business was originally carried on in partnership by Messrs. Fletcher & Jackson. The company was registered to take over the concern a little more than two years ago, and had a nominal capital of £600. Subsequently the two vendors each found a sum of £300 in cash, and in return received debentures for a like amount in the company. Debentures for a further £200 were issued during the present year for cash advanced. It was pointed out that the assets only amounted to £856, and were subject to debenture charges of £800, so that there was really only a balance of £50 odd for the unsecured creditors. The liquidator said that there was a desire to continue the business, as there were several important contracts in hand. The directors had not drawn anything from the company, and they hoped in a few weeks to be able to make an offer to the unsecured creditors. It was decided by the creditors to leave the matter in the hands of Mr. Pensam.

Electric Time Service.—We are informed that the Synchronome Co., Ltd., of 32 and 34, Clerkenwell Road, are installing their system of uniform and accurate time-keeping throughout a number of buildings, of which the following are some of the more important :—Vickers, Ltd., new offices, Barrow-in-Furness ; Marconi's Wireless Telegraph Works, Chelmsford ; The British Thomson-Houston Meter Works, Coventry and Lamp Works, Willesden ; Diesel Engine Co.'s new offices ; four-faced public turret clocks at West Bromwich and Wednesbury ; Rangoon railway station of the Burmah State Railways ; Waterloo Station extension and the Nine Elms engine shed for the L. & S.W. Railway ; Amalgamated Press, Farringdon Street, E.C. ; *The Daily News and Leader*, Bouverie Street, E.C.

Bankruptcy Proceedings.—John William Garsden (trading as W. Garsden & Co.), electrical engineer, 24, Preston New Road, Blackburn.—The adjourned public examination of the above-named debtor was held at St. John's Lodge, Richmond Terrace, Blackburn, when the Official Receiver stated that the debtor had been made liable for a partnership debt, and he gave this as the cause of his present position. Mr. H. S. Haworth, for the trustee, said he had no further questions to ask, and on the application of Mr. Tom Backhouse, the case was closed.

R. E. Walker, 16, Widemarsh Street, Hereford, electrical engineer.—The order of July 16th last has been discharged, subject to a condition.

Catalogues and Lists.—The Electrical Co., Ltd., 122-4, Charing Cross Road, W.C.—Price list No. 12 of small motors and tools ; the former range from $\frac{1}{80}$ to $\frac{1}{8}$ B.H.P. in a variety of patterns, including a portable household motor for performing a number of functions.

The Foster Engineering Co., Ltd., Wimbledon, S.W.—Pamphlet describing a new line of "Standard" oil-filled transformers for 1 to 100 KW., 50-60 cycles, and up to 3,000 volts ; the specification and dimensions are given, and various special apparatus are also illustrated.

Messrs. Mavor & Coulson, Ltd., 47, King Street, Mile End, Glasgow.—Leaflet describing the "Dandy" ventilators for mine headings, &c.

The Schniewindt Electric Co., 40 and 41, Staniforth Street, Birmingham.—Leaflet relating to the Schniewindt-Asbestos woven-wire resistances, which are now, with other specialities, manufactured at the company's own works in Birmingham.

The General Electric Co., Ltd.—The company has made arrangements with the Holophane Co. for the sale of their various products, and has just issued "The only Complete Catalogue of Holophane Glassware." It will carry the largest stock of Holophane glassware in the United Kingdom. This catalogue contains the complete range of designs of Holophane and Holophane Benjamin products, beautifully illustrated on fine art paper, and gives a detailed description of scientific illumination. The new inverted type of Holophane bowls, which serve for indirect lighting, is shown, as well as the "Stiletto" reflectors in the usual extensive, intensive and concentrating types, and reflectors for residence use. Other features of the list are the "Uniflux" reflectors and reflector bowls, reflectors specially designed for use in factories, dockyards, &c.

Pamphlet No. L 1,591, of electric bells and accessories ; and C 1,561, of "Geekoduct" continuity devices, earthing devices, &c.

Messrs. Siemens Bros. Dynamo Works, Ltd., Tyssen Street, Dalston, London, N.E.—For the convenience of contractors, this firm is now issuing an attractive showcard on which samples of all types of "Wotan" battery lamps can be mounted, and by means of which the various types of lamps can be displayed to the public.

In the centre on a vignetted background are illustrated all the different patterns, and a brass spring clip is fixed in a suitable position on each, so that a lamp of similar type is fixed directly above the illustration, and after a lamp has been removed, an illustration of it remains. The cards are supplied at the actual value of the lamps mounted thereon, less, of course, the usual trade discount. The sample showcard also depicts the various applications to which these battery lamps can be applied.

Messrs. Townshend's Art Metal Co., Ltd., Ernest Street, Holloway Head, Birmingham.—Catalogue of the "Calor" electric cooking and heating appliances, in which the heating element consists of non-oxidisable resistance spirals mounted on a refractory clay base which becomes red hot, and is readily renewable. The appliances include food warmers, hot plates, a variety of utensils, electric irons and "bright glowing electric fires."

Messrs. Falk, Stadelmann & Co., Ltd., 83-87, Farringdon Road, E.C.—Catalogue No. 342 of "Efesca Wire" lamps, British-made, for which exceptional strength is claimed; they are made in sizes down to 10 c.p. for low voltage, and 16 c.p. for high voltage, and up to 1,000 c.p., in various shapes. Carbon lamps are also listed, and auto-transformers, &c.

Werths & Co., 41, Aldersgate Street, E.C.—Pamphlet describing the firm's specialities, viz., cast-steel draw plates and dies for rod and fine wire drawing; chilled cast-iron dies; steel and tools for wire manufacture; diamond dies and powder; and draw-flats.

Mirrlees Condensing Plant.—A repeat order has been placed with the Mirrlees-Watson Co., Ltd., of Scotland Street, Glasgow, by Messrs. D. Colville & Sons, Mothewell, for a barometric jet condensing plant directly connected to rolling-mill engines, with a duty of 200,000 lb. steam per hour. The company are also supplying numerous sets of their Mirrlees-Leblanc multi-jet plant, amongst other recent orders being two sets each for John Foster and Sons, Queensbery; Lewis Merthyr Colliery, and East Hetton Colliery, while their Mirrlees-Leblanc rotary air pumps have been supplied to several home and foreign works. Their surface and jet condensers have also been in demand for electricity works and factories.

Trade Announcements. — The Schniewindt Electric Co. have recently opened a new works at 40 and 41, Staniforth Street, Birmingham, for the manufacture of their asbestos woven net resistances, and resistances to any specification; electric heating and cooking apparatus and elements, woven work in wire and asbestos, &c. These specialities were formally manufactured by Mr. Schniewindt, Neuenrade, Westphalia, but at the special request of numerous customers, these works have been started in Birmingham.

The business carried on for many years by the late Mr. James Tate, electrical and mechanical engineer, of 182, Harris Street, Leeds Road, Bradford, and which has since been continued by his executors, has been sold to Mr. William Henry Wilkinson, who, for a considerable time, was Mr. Tate's chief assistant.

Messrs. Quincey & Son, electrical engineers, announce that they are giving up their business at 298, Baker Street, Enfield, N. In consequence the stock is to be disposed of by auction on September 24th.

LIGHTING and POWER NOTES.

Aberdeen.—The T.C. has agreed to all round reductions in the price of electricity supply. For lighting, the flat rate is to be 3½d. per unit; heating and cooking, 1d. to ¾d. per unit; power, 2½d. to ¾d. per unit according to quantity; and traction ·85d. per unit, with subsequent adjustment.

Acton.—Very considerable headway, says a correspondent, has been made by the Metropolitan E.S. Co. since the transfer of the Acton Council's electricity undertaking, some 18 months ago. Both in respect to lighting and power, the past year's trading has been very successful, the output increasing by about 100 per cent. and necessitating the erection in the southern portion of the district, of a sub-station adjoining Wilkinson's sword factory, which is now in course of construction.

Afghanistan.—News from Kabul is to the effect that the sanction given by the Amir to the scheme for generating electricity at Jabal Siraj north-east of the capital, is really to be effective this time. The idea is to provide electric power for the arsenals and workshops at Kabul, incidentally light will be available for the Amir's palaces and city generally, also the rifle, gun, and ammunition factories, not to mention the mint, have machinery which can be run by electricity, and a great saving should be effected when the Jabal Siraj installation is in full working order.

Balby-with-Hexthorpe.—The Doncaster Corporation, which obtained powers in 1898 to supply electricity within the borough, and recently secured extended powers in the Wheatley district, now desires to still further extend its area of supply, so that the district of Balby and Hexthorpe may be included. Application for support has been made to the District Council, and the latter has decided to deal with the matter in committee.

Barnsley.—The accounts of the Corporation for the past year, issued on Monday, show that the electricity department, the capital expenditure of which is now nearly £100,000, yielded a net profit of £2,383, with an average sale price of 2·054d. per unit.

Blackburn.—The borough electrical engineer (Mr. P. P. Wheelwright) has been instructed to prepare for submission to the Electricity Committee, a report on the question of new works for the electricity department.

Bradford.—The Electricity Committee has decided to change the system of electricity supply along certain roads in the Thornbury district from direct-current to alternating-current. The cost of the work is estimated to be about £1,480, and the cost of replacing mains at present in existence will be defrayed out of revenue.

Braintree. — The Witham Electric Light Co. has approached the U.D.C. with reference to the formation of a local syndicate to carry out an electric supply scheme for the town on lines similar to those at Witham. The Council has referred the whole matter to the Finance Committee.

Brighton.—The T.C. has reduced the price of current to consumers of 15,000 units per annum for lighting, from 4d. to 3d. per unit.

The T.C. has received from the L.G.B. sanction to a loan of £3,770 for the extension of the distributing and feeder mains and house services, and extension of the switchboard.

Burnley.—The Council has decided to obtain loans for £17,000 and £6,400 for the purpose of carrying out electricity extensions.

Cheltenham.—The T.C. has decided to at once proceed with the extension of the electrical mains to Prestbury and Leckhampton.

Continental Notes.—France.—A Sulzer-Diesel engine installation at St. Chamond central station consists of two two-stroke engines of 1,000 and 2,000 h.p. respectively. The oil is stored in cement tanks lined with glazed tiles, from which it is pumped into service tanks near the engines. Circulating water is stored on the top of the engine house, and is used for piston cooling as well as cylinder cooling.

La Compagnie Générale Electrique de la Champagne has secured the concession for the electric lighting of no less than 54 small towns and villages in the Departments of Marne, Aisne and Ardennes.

Germany.—An agreement has been arrived at between the municipal authorities of Brandenburg-am-Havel and the A.E.G., of Berlin, whereby the latter will take over the municipal central electric lighting station in the town of Brandenburg and operate the same during a period of 40 years.

Dudley.—The chairman of the Electricity Committee moved at the last Council meeting, that the electrical undertaking of the Corporation be sold at once upon terms agreed upon by the Committee. The *Birmingham Daily Post* says:—"Since publicity was given to the proposal nearly a fortnight ago, it has been generally supposed that the prospective purchasers were a company having a large electrical station at Ocker Hill, and possessing Parliamentary powers in all the districts immediately surrounding Dudley, but inquiries show that this surmise is incorrect. A *Post* representative was informed, on very good authority, that the offer to purchase which the Council are asked to accept emanated from the British Electric Traction Co., with whom negotiations have been conducted, and that two other companies are involved in the transaction—the Birmingham and Midland Tramway Co., and Shropshire Power Co. The offer embodies, our representative was informed, a guarantee to repay the whole of the outstanding loans on the power station, amounting to £68,000, with interest, plus £13,000, which includes the cost of the arbitration proceedings relative to the price of current to the tramway company, stated to be about £8,000, and also various sums expended on the station independent of money raised by loans. The security for the carrying out of the proposed agreement would be a mortgage on the power station and an arrangement implicating two of the companies named, the combined capital of which is about £2,000,000. The Corporation, however, would still remain liable for the repayment of the loans and interest in the event of these annual obligations not being met by the purchasers."

At a meeting of the Dudley Traders' Association and the Dudley Ratepayers' Protection Association, a resolution was passed urging the Council not to sell the concern until the matter has been fully placed before the public and was thoroughly understood by the ratepayers.

The T.C. on Tuesday decided to sell the electrical undertaking. The purchasers, who take over the concern as from last March, undertake to maintain the present rates for current for three years.

Dundee.—The T.C. has recently improved the street lighting of the city. In place of the old open-type arcs, 88 "Angold" magazine flame lamps have been installed. The change was so well organised that all the new lamps were switched on at the usual lighting-up time. The work of changing was commenced at twelve o'clock midnight Wednesday, August 28th, and the whole of the 88 new lamps were fixed and ready for switching on by mid-day on Thursday, the 29th.

Ealing.—Mr. J. D. Knight, borough electrical engineer, in a report to the T.C., says the time is now ripe for the appointment of an official publicity agent to the undertaking, whose sole duty would consist of canvassing the district continually from one end to the other. Some 12,000 pamphlets, showing the various purposes for which electricity may be used and the benefits accruing to the user, have been delivered to householders during recent months; and a canvass of shopkeepers for outside lighting by means of arc lamps has met with very favourable results.

Glasgow.—Through the extension of the boundaries of the city, and the inclusion of the municipal areas of Govan and Partick, a number of departmental adjustments have had to be made. At a recent meeting of the City Council there was submitted a correspondence with the town clerk of Partick as to new electrical cables required by the Partick electricity department, to give a supply of electricity to the granary now in course of erection by the Clyde Trustees at Meadowside. It was agreed to remit to the Electricity Committee and the engineer of the electricity department to arrange with the Partick engineer for the providing of the necessary cables.

Ex-Bailie P. S. Stewart has given notice of the following motion for consideration at the next T.C. meeting :—"That it be remitted to a Joint-Committee of the Tramways and Electricity Committees to consider and report as to the advisability of putting under the control of one Committee, the generation of electricity for all purposes."

At a recent meeting the Health Committee of the Glasgow T.C. it was decided to install, at a cost of £70, an electric motor at Belvidere Hospital for the purpose of driving the laundry machinery. After further consideration, however, the scheme has been widened to include four motors at an additional cost of £120.

Officials of the electricity department have just completed a smart piece of work in what is claimed to be record time. On Thursday of last week a large engineering firm reported that through a breakdown of their steam plant the works had come to a practical standstill, and asked the department to assist them out of the difficulty as expeditiously as possible with the supply of 1,000 KW. Mr. Lackie and his assistants at once set to work, and two rotary converters were transferred to the works of the firm, along with the necessary switchgear, while the mains were also laid, the whole of the operations being concluded by Sunday evening. The works were able to resume full operations on Monday morning.

Greenock.—An appeal has been made by certain power users in Port-Glasgow to the B. of T. to use its influence in order to enable Greenock Corporation and the Port-Glasgow Town Council to come to an agreement on the question of the former authority entering the latter's territory to supply a number of the shipyards with electricity. The Board has communicated with the Port-Glasgow Council, which has replied that, while adhering to its previous decision not to give the 30 years' guarantee sought by Greenock, it is willing to attend any meeting arranged by the Board. The Greenock Corporation has also agreed to take part in the negotiations.

Horeham Road (Sussex).—An effort is being made to secure an electric supply for the parish by the formation of a company. The proposed scheme entails an outlay of £3,000, which includes the provision of cooking and heating stoves and about 30 public lamps.

Leek (Staffs.).—The U.D.C. has decided to obtain a loan of £1,400 to defray the cost of laying additional cables for supplying electricity.

London.—ISLINGTON.—On the evening of September 9th a junction box fused at the Council's electric lighting station, causing a fire, and the staff, in order to avert further damage, cut off the whole of the supply from the station, thus throwing the whole of electrically-lighted Islington into darkness. Naturally the effect was severely felt in the absence of street lighting in the main thoroughfares and in the many public buildings which depend on the supply; the latter was, however, fully restored on the following day.

Lytham.—At a ratepayers' meeting at Lytham, on Monday evening, there was a discussion on the suggested order for the supply of electricity to the district. As matters at present stand both the Lytham and St. Annes Councils are intending to apply to the B. of T. for a provisional order for the supply of current in the town.

Middleton.—On the recommendation of the Electricity Committee, application is to be made to the L.G.B. for sanction to borrow £2,000 for a steam dynamo.

Motherwell.—The annual report of the burgh electrical engineer shows a net loss on last year's working of £1,689. The output was 3,553,113 units, a decrease of 365,948, but this is largely accounted for by the stoppage of the public works during the miners' strike. The capital expenditure involved in the installation was £113,739, and the total revenue for the year was £15,158. A committee has been appointed to consider and report upon the exact state of the undertaking.

Nelson.—The T.C. has decided to supply current for outside illuminations during the forthcoming shopping festival at 2d. per unit.

Rochdale.—An application having been received from the Milnrow D.C. for terms for a bulk supply of electricity, the Gas and Electricity Committee has decided to submit the same terms as those offered to the Whitworth D.C. A further supply is to be given to Whitworth for the motor at the latter's sewage works.

Scarborough.—The B. of G. has been recommended by a Committee to adopt a scheme which includes lighting the whole of the workhouse premises by electricity. The combined heating and lighting scheme is estimated to cost £5,150.

South Africa.—According to the *British South African Export Gazette*, a second extensive installation, including two 600-H.P. suction gas plants for generating electricity, and an electrical washing plant, is contemplated by the Colonial Mining Co. for its diamond mines in German S.W. Africa.

Southampton.—The B. of G. has passed a resolution sanctioning the expenditure of £850 on a scheme of electric lighting for the workhouse infirmary at Shirley Warren.

Stroud (Glos.).—Mr. V. A. Lawson, of Cirencester, has solicited the approval of the U.D.C. to an electric light scheme for the town, which it is proposed to carry out under a prov. order to be applied for. The Council has decided to seek further information of the scheme.

Todmorden.—The accounts in the electricity department for the past year shows a revenue of £2,392; expenses, £1,232; and gross profit of £1,160. Sinking fund charges, however, amounted to £1,220, leaving a deficit of £59, against a deficiency for the previous year of £33. The authorised borrowing power of £20,000 has been exercised, and the whole amount expended. The total outlay on capital account is £21,945.

Truro.—The Gas Co. has decided to apply to the B. of T. for a prov. order for E.L. The chairman of directors has announced that electricity cannot be profitably supplied to the city, but as there were a number of residents who had a preference for the electric light, the company was prepared to do its best to meet their desires.

Wakefield.—Application is to be made to the L.G.B. for sanction to the borrowing of £3,000 for mains, £500 for sub-stations, and £500 for transformers. The contract for the lighting of the Market Hall has been given to the Gas Co. The failure of the electricity undertaking to obtain it was due to the fact that the Gas Co. had already a number of fittings in the hall; the quotation for illumination compared favourably. The electricity department has opened a permanent showroom in the centre of the city, in which last week a very successful heating and cooking demonstration was held. This showroom it is proposed to run on co-operative lines between the manufacturers, local contractors and the electricity department. The two former are invited to make whatever use they think fit of the premises as a showroom, and the electricity department provide the building, staff, current, advertising and all other such portions of the work. Whatever sales are made to customers will be made through the local contractors, and it is hoped that it will produce good results.

West Bromwich.—At a special meeting of the T.C. on Friday, last week, an important report was submitted by the Electricity Committee. The firm of Messrs. Braithwaite & Thirk have agreed to take at least 80,000 units of electricity per annum for five years, and to enable the Committee to give this supply and provide for further demands from other customers in the district, it recommended that an additional feeder cable be laid down at an estimated cost of £2,650, and also a new additional distributor cable, the total estimated expenditure in the district being £3,010. About £1,500, it was stated, had been spent on extensions of mains, and the Committee recommended that application be made to borrow the amount required, and also £2,000 to cover prospective expenditure, the total amount to be applied for being £6,500. It also recommended the acceptance of the tender of the Electrical Engineering and Equipment Co., Ltd., for the supply of the cable. This is a Continental firm, but it was pointed out by the Committee that the tender was so very much below that of any of the tenders from English firms that the Committee felt it had no alternative but to recommend its acceptance. Councillor Halford said there would, no doubt, be criticism in some quarters over the Council giving a contract to a foreign company, but he did not think the ratepayers at large would blame them when they understood that there was a difference of £500 between this firm's tender and that of the lowest British manufacturers. The tender, he repeated, was more than £500 lower than any English tender, and there would be a saving in the repayment of the loan making the total difference about £750. The Council adopted the Committee's report.

Whitwood (near Pontefract).—In connection with the electricity undertaking, the L.G.B. has formally sanctioned the borrowing of £2,480, for a period not exceeding 12 years, for works already executed; £300, for 15 years, for mains and services; and £120, for five years, for meters.

TRAMWAY and RAILWAY NOTES.

Audenshaw.—At the meeting of the D.C. on the 5th inst., it was reported that the Oldham, Ashton and Hyde Electric Tramways Co. had returned the rate-demand notes, contending that the demand should be corrected, as it was only liable to be rated at one-quarter, by reason of a recent decision that a tramway was a railway for rating purposes. A notice of appeal was also received from Manchester Corporation on the same lines with regard to its undertaking in the district. The clerk was instructed to write to the tramway company that its contention was not accepted, and that it should appeal against the rate in the ordinary way. The clerk was also asked to take steps to contest the appeals at the Quarter Sessions.

Barnoldswick.—The Council has been notified of the proposed construction on the overhead system of an electrically worked railway from Colne to Barnoldswick and Earby, a distance of about 5½ miles, at an estimated cost of over £60,000. The scheme is being promoted by Messrs. Matthew Watson, Landless and Pearce, architects and surveyors, of Liverpool and Burnley.

(*Continued on page 424.*)

THE DESSAU-BITTERFELD RAILWAY.

SIEMENS-SCHUCKERT OVERHEAD WORK.

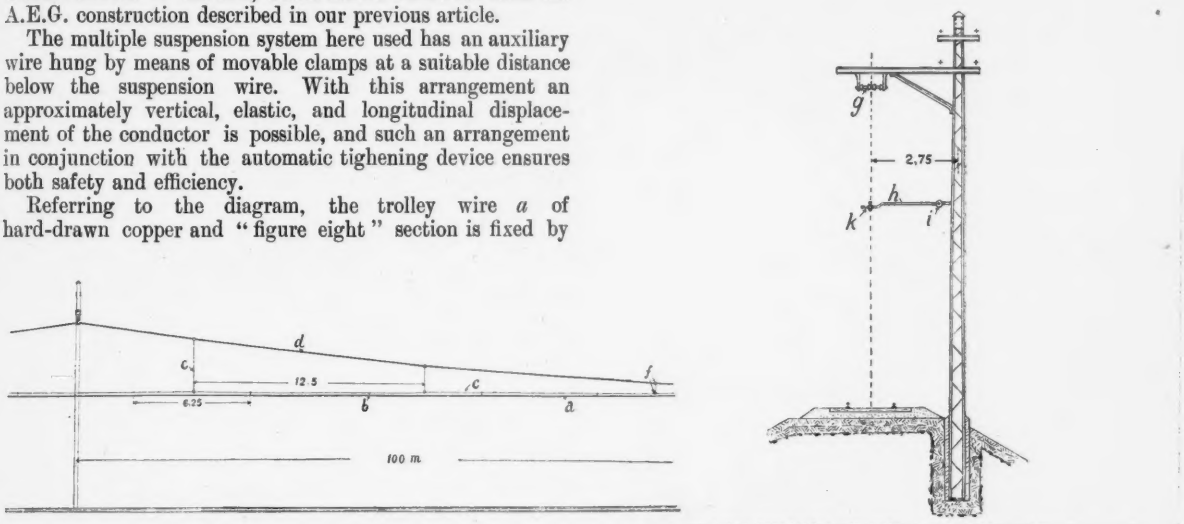
We gave, in our issue of May 24th last, a short description of the Dessau-Bitterfeld single-phase railway, the electrification of which was shared equally by the A.E.G. and Siemens-Schuckertwerke. Thus, the latter firm were responsible for the overhead equipment of the Raguhn-Dessau section of the line, which differs somewhat from the A.E.G. construction described in our previous article.

The multiple suspension system here used has an auxiliary wire hung by means of movable clamps at a suitable distance below the suspension wire. With this arrangement an approximately vertical, elastic, and longitudinal displacement of the conductor is possible, and such an arrangement in conjunction with the automatic tighening device ensures both safety and efficiency.

Referring to the diagram, the trolley wire *a* of hard-drawn copper and "figure eight" section is fixed by means of special clips *b* to a so-called auxiliary suspension wire *c* which runs approximately parallel to, and vertically above it. The clamps are arranged to grip the trolley wire tightly, and to hold the auxiliary wire only loosely. By this means a slight longitudinal displacement of the clamps along the auxiliary wire is possible. The clamps are also arranged to permit the trolley wire to move vertically, due to the pressure of the trolley or bow, giving certain contact between the bow and wire. The auxiliary suspension wire *c* is attached to the wire *d* at points whose distance apart is exactly double the distance between the points at which the trolley wire is supported. The line is suspended on vertical supporting wires *e*, which are fixed by special clamps *f*.

The suspension cable is carried on insulators *g*; and to prevent lateral movement of the live wire, it is held in position by a strut *h* at each pole. The struts are constructed of tubing, and are insulated from the pole by the insulator *i*. They are connected to the trolley wire by clamps *k*, specially constructed to allow the trolley wire to give both vertically and longitudinally.

All current-carrying parts are doubly insulated from the masts or brackets, a large factor of safety being allowed.

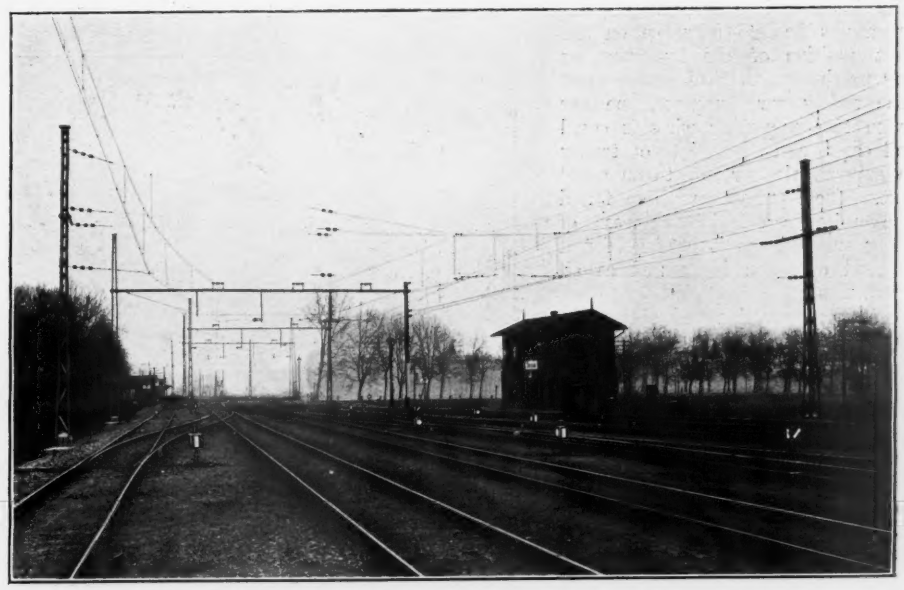


The Siemens-Schuckert Multiple Suspension System of Overhead Construction.

The independent longitudinal movement of the trolley wire allows of its being tightened without distorting the supporting wires, and as sometimes happens in other systems, causing the suspension wire to break.

This feature is a great advantage for high travelling speeds where even tension of the live wire is required. The tension is obtained by means of automatic tension devices, which are placed at intervals of about 1,300 metres, and act by means of weights. Special attention is drawn to the fact that in case of breakage of the trolley wire, the actual supports—viz., auxiliary wire and suspension cable do not suffer since, as already mentioned, the trolley wire clamps can move along the auxiliary wire.

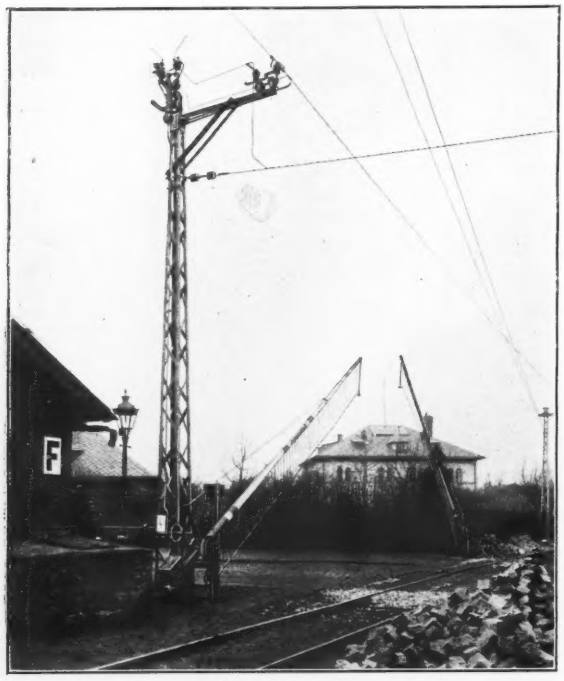
To compensate for the variation in length of the suspension and the auxiliary wires due to temperature changes, special tightening devices are not necessary, as the tension in the parts is arranged with a view to safety at the low



View on Railway Showing Siemens-Schuckert Overhead Construction.

temperatures in case of breakage. The variation of tension in these wires has no appreciable influence on the sag of the line or on the efficient collection of the current.

The supporting wire is suspended with a comparatively large sag, and temperature variation has practically no effect on it. Further, the change in length due to elasticity,



Road Crossing and Gate, Dessau-Bitterfeld Railway.

which is considerable owing to the twisting of the cable, is compensated for. As a consequence, a suspension wire hung at a medium temperature shows extremely small alterations in height at high or low temperatures, and in the trolley wire only a very slight deflection is perceptible along the whole span.

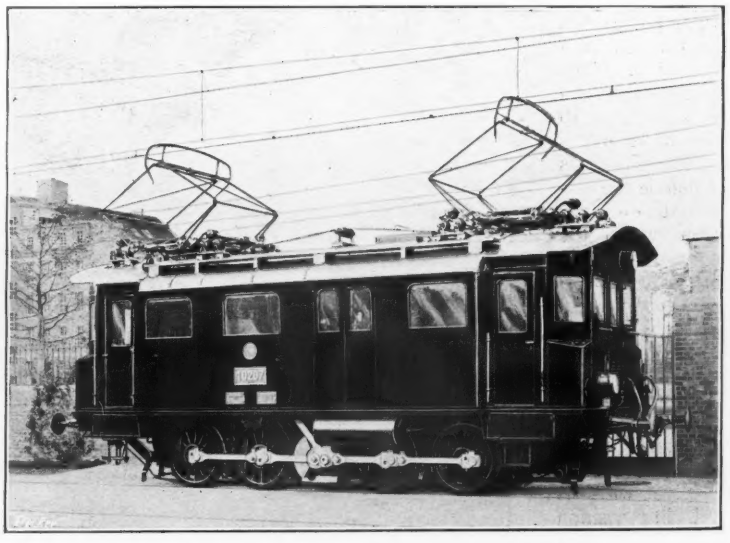
The alteration in length of the auxiliary wire at various temperatures has no influence on the correct position of the live wire, as owing to the symmetrical arrangement of the trolley wire supports, the sag between two supporting wires is equal in all cases, and the points of trolley wire support rise or fall to an equal extent. These points have been found to be quite correct in the case of existing systems, and it has been found that good operation is assured at all temperatures.

To facilitate erection and obtain the proper tension, the suspension and auxiliary wires are provided with turnbuckles, with a left and right-handed thread, at intervals of 250 to 400 metres. The electrical connection of the trolley wire sections on each side of the automatic tightener is made either direct, or, if between two separate sections of the line, through a switch, which is fixed to the pole in any suitable position.

With the exception of the end-terminals for the wires and the turnbuckles, the connectors are of cast-brass, as these are less liable to rust. If iron is used for these parts, the paint with which they are covered before erection is apt to become damaged, and if not carefully repainted afterwards, the parts will rust. The clamps are provided with steel screws and brass nuts.

All other parts of the overhead system are supported by clamps in the same way as the trolley wire, so that all soldering work is avoided; the trolley wire is, therefore, not heated, and consequently retains its maximum hardness and resistance.

The Siemens-Schuckertwerke were also responsible for some of the locomotives which, together with the overhead work, are illustrated in the accompanying figures.



Siemens-Schuckert Electrical Goods Locomotive.

NORWICH ELECTRICITY WORKS AND THE FLOOD.

It is estimated that on August 26th nearly 400 million tons of rain fell in Norfolk alone—an average of 3-in. depth over the whole country. The rivers and dykes were quite unable to deal with this vast quantity of water, and the flat parts of the country were virtually shallow Broads.

The inundation was especially severe in the Norwich district. The only outlet for the water here is the River Yare, which meanders over a winding shallow bed, the fall in which from Norwich to the sea is only 20 ft. There is a 4-ft. tidal variation in the river which hinders the escape of flood water. On August 26th 6·5 in. of rain fell in this district in 24 hours; 7·5 in. in 29 hours, and over 11 in. during the month of August. This unprecedented downpour caused a rise in the river level of about 12 ft. near the Norwich central station at the height of the flood.

For some distance above and below the station, the river is constricted by walls and buildings, so that a sudden inflow of water commenced directly the latter rose above openings in the side walls. That the flood in the station was so severe as to necessitate cessation of supply was due to a combination of unfortunate conditions, which could not be foreseen and which are very unlikely to recur. The buildings were erected nearly 20 years ago, and the engine room floor level was placed well above the previous record flood level (1878; 3 ft. lower than the floor-level). Since that date the river has been dredged considerably, and a number of mill dams above the station have been removed, so that only an extraordinary period of rain fall culminating in a prolonged heavy downpour could bring the river up to its recent flood level.

At the time of the disaster, the station was in that state of upset which inevitably accompanies such important extensions as are now in progress. Spare and dismantled parts covered much of the floor and were immersed during the height of the flood. The most serious of the unusual conditions in the station was the work proceeding on the new turbo-generator foundations. Some 10-13 ft. below the surface of the station site there is a 3-4 ft. layer of peaty soil, below this again is 2 ft or so of gravel and then chalk.

In excavating the station foundations, no serious percolation from the river (which is here only a few yards away), was experienced until the peaty stratum was penetrated, but thereafter great trouble was experienced. The new turbine foundations are only partially completed and infiltration through them was one of the most serious modes of ingress of the flood water.

The normal river level during the wet season is about 8 ft. below the engine-room floor, but by 3 a.m. on August 27th there was 3 ft. of water in the basement, and the water was then within 4 ft. of the engine-room floor.

Mr. Austin (the assistant engineer), who was in charge in the absence of the chief engineer, immediately proceeded to dam up such inlets as were accessible and capable of being closed. The Corporation pump store was flooded, hence the only pumps available were those lying spare in the station. Hand pumps were mounted over the various pits containing the engine and turbine auxiliaries, and by 11 a.m. a 6-in. centrifugal pump had been arranged to throw water out of the engine-room window. By this time the water in the basement was 5 ft. 6 in. deep and within 18 in. of the engine-room floor. The river continued to rise rapidly, much water flowed in by way of manhole covers and disused connecting ports in the condensing water culvert and many temporary clay plugs and dams gave way under the increasing water pressure. Another 6-in. pump was got to work during the afternoon, but at 9 p.m. the water (which was now 18 in. above the engine room floor level outside the works) reached the terminals of one of the dynamos, a "short" occurred, and the station had to be shut down. Up to this time, normal supply had been maintained, temporary cables being carried from the generators to the switchboard (the regular cable ducts being flooded early in the day), and a dam built across the mouth of the outgoing feeder tunnel.

After the cessation of pumping, water speedily flowed into the power house, submerging the engine-driven sets to their shafts (see our views), but the turbine sets, being erected on raised foundations, were only submerged to their bed-plates. All the auxiliary machinery was under water. The conditions in one of the boiler houses are shown in one of our views. The fires of the water-tube boilers were not drawn till the flood was within 12 in. of the chain grates.

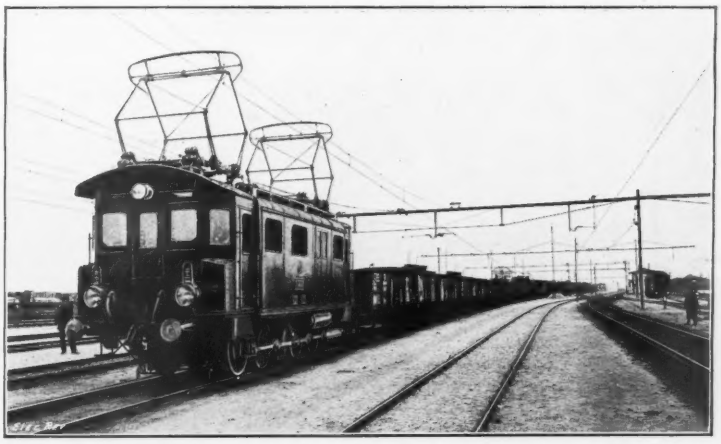
The waters began to recede at 5 a.m. on August 28th, steadily falling during the next 24 hours to about 1 ft. below floor level.

The submerged auxiliary motors were raised as soon as possible, and arrangements were made for the field coils of all the wet machines and the armatures of the smaller motors to be baked as soon as they could be removed.

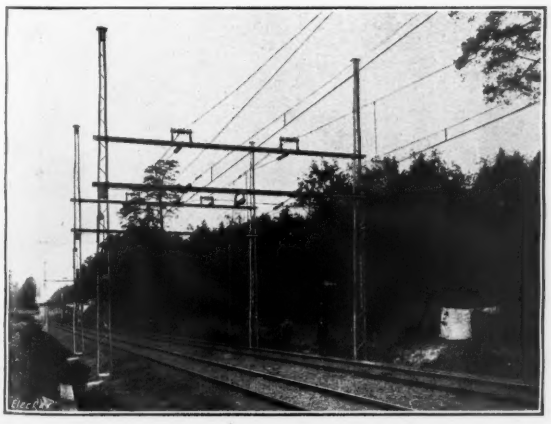
During Tuesday night, the whole of Wednesday and Wednesday night and the earlier part of Thursday, the supply was completely interrupted. The turbo-dynamos were dry but their auxiliaries were flooded, and temporary provision had to be made for a circulating water supply. One turbine was running to atmosphere by Thursday afternoon, the first duty performed being the charging of the battery. The latter had practically discharged prior to the shut-down, and could not be recharged till the flooded booster set had been dried. By Thursday evening a temporary circulating water supply had been arranged by belt-driving one centrifugal pump through an overhanging pulley mounted on its projecting spindle—the only bearing at this end being the gland—and another (in the basement) through a belt running on the commutator of the flooded pumping motor. Both expedients proved satisfactory; less brutal arrangements were made as soon as possible, and the gland and commutator were little the worse for their experience.

Messrs. Caley have a private generating plant, and also take a limited supply from the Corporation mains. They were able to supply 300-400 amperes to the latter for pumping, street lighting, &c., after shutting down their own load on Wednesday and Thursday evenings, and this was most valuable.

The station output was confined to a small pumping supply on Thursday morning, and to battery charging in the afternoon and evening. At 7 a.m. on Friday, the 1,000-KW. turbine was connected to such of the public supply mains as



Electric Goods Locomotive Drawing Train, Dessau-Bitterfeld Railway (page 419).



Examples of Siemens-Schuckert Overhead Construction, Dessau-Bitterfeld Railway (page 419).

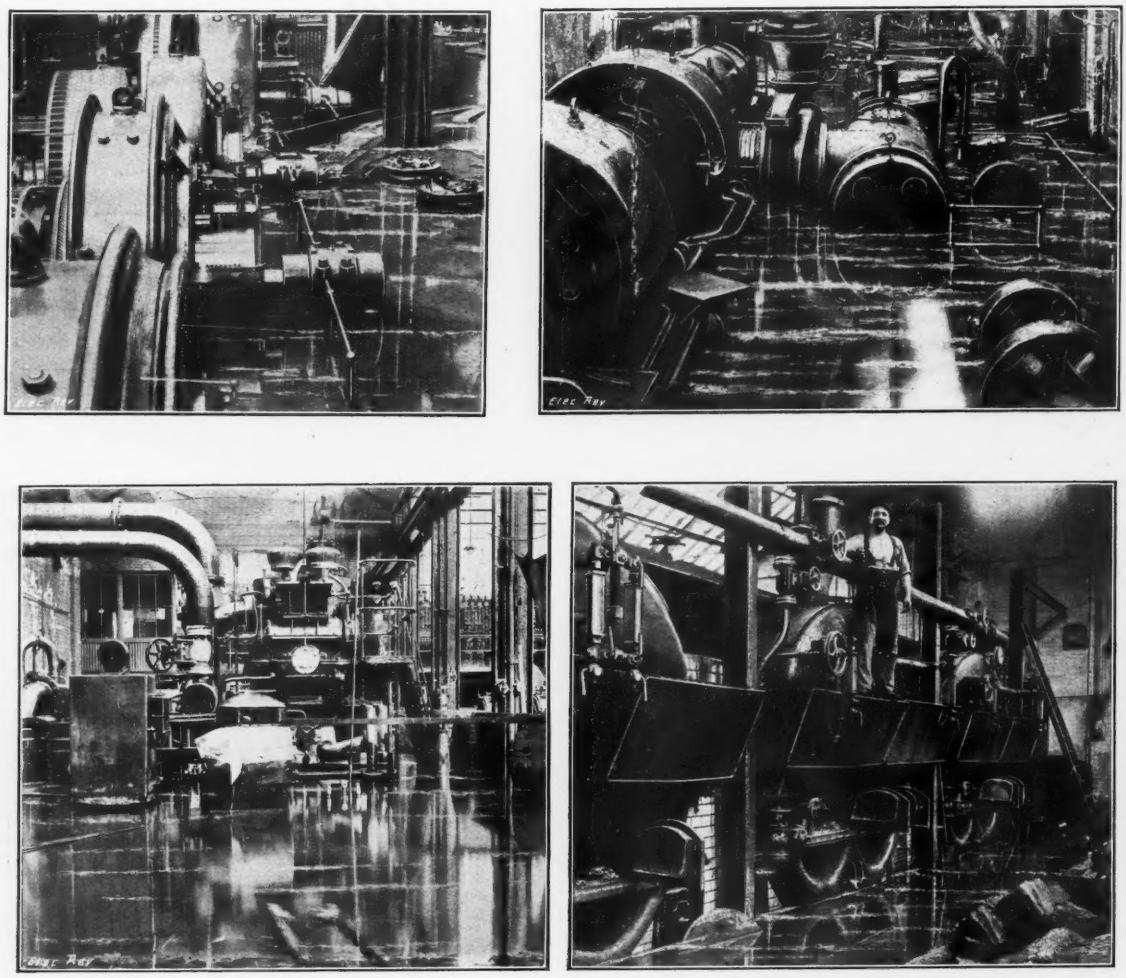
were not incapacitated by the flood. Thereafter the total output rose rapidly to the normal. The two turbo-units (1,000 and 750-KW. capacity respectively) were able to cope with the total demand until such time as the engine sets were dried out.

The original bare copper distributing mains have been gradually replaced by B.I. & H. and St. Helens cables, but many miles of the former are still in use (and give satisfaction apart from the low insulation resistance obtainable). Streets containing bare mains and junction boxes, on both systems, controlling supply to about one-third of the town were submerged, and a number of joints were broken by road subsidence. There was naturally some delay in restoring service to these areas, but within a week from the date of the disaster conditions were practically normal so far as the public was concerned. As soon as possible, further sections of the bare mains will be replaced.

The industrial inconvenience attributable to the cessation of supply was reduced by the fact that many works were flooded or short-handed, either owing to the inaccessibility of the works to the employés or owing to the latter absenting themselves to attend to their own troubles.

Drying the Machines. — During Tuesday night and Wednesday the engine room was flooded with a mixture of dirty water and oil which had flowed out of the engine crank cases. After cleaning and rough drying the machine windings affected, it was found that they still were too wet to be dried by the application of a heavy, low-pressure current, hence field coils and the smaller armatures were dispatched to drying ovens, and, on the occasion of our visit, the armature of the 750-KW. Crompton-Belliss set was in its bearings and being dried by steam radiators mounted in place of the field coils. The ends of the machine were covered with tarpaulins, and small fans maintained a brisk air circulation round the armature. The armature was expected to be fit for service in two or three days.

The remaining flooded units (two 440-KW., one of 500 KW.) were being dried by coke stoves placed inside a temporary wooden framework built right over the three sets and covered with strong paper. "Turk" stoves were being used to heat dry air to about 100° F., and fans were arranged to maintain a continuous air flow through the enclosure. It was hoped to dry the machines in a week or so by this means. The "Turk" system avoids the cost and labour of taking down the dynamos, while leaving the workmen free for other more urgent duties.



Typical Views in the Flooded Norwich Electricity Works.

Loss to the Station.—The cost of the disaster includes £500-£700 loss in revenue during the week of the flood, and a similar expenditure in cleaning and drying the works and machines, and in placing the distributing system in order again. Probably the total loss to the station will amount to about £1,500.

Certain gas enthusiasts in the neighbourhood have published statements concerning the failure of the electricity supply which are in very bad taste. Fortunately, we can afford to congratulate the gas company on having just sufficient gas in their gasholders to last from Tuesday afternoon (when the retort fires had to be drawn) till production could be recommenced, and on their enterprise in providing a temporary gas supply to some residents in streets where the electricity mains were disabled for several days.

Everything possible was done to minimise the magnitude of the disaster at the central station, and to restore supply after the waters had subsided. We have great pleasure in

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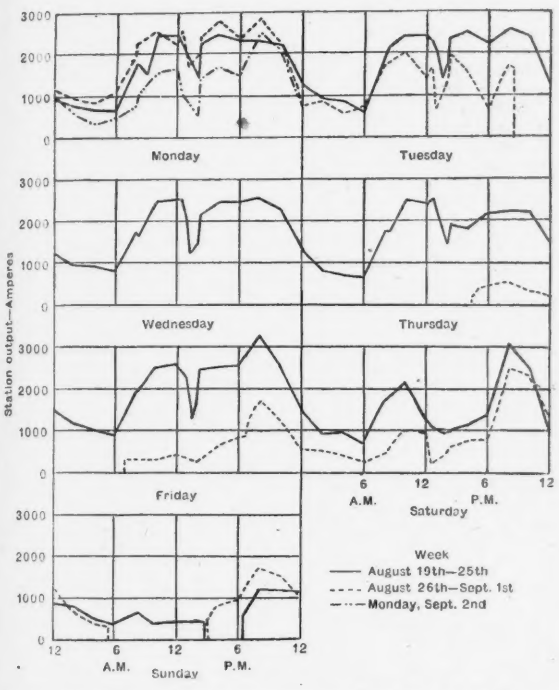
recording the chief engineer's gratitude to his staff for their assistance, and to consumers for the forbearance with which they accepted the position.

The disaster could not have been foreseen, the previous highest recorded flood (1614) being 18 in. lower than the present flood level. No such flood is likely to recur for decades—probably not for centuries—and, in any case, the station is not likely to be caught again with its concrete foundation raft cut away. As many minor precautions as



Comparative Load Curves showing the Effect of the Flood.

possible will be taken against the injurious effect of a possible future flood, and the wall along the river front will be rebuilt higher.

Before leaving this subject, readers will doubtless be interested in the following brief description of the important extensions in progress at Norwich and in particulars of recent supply developments.

The generating equipment of the station (which commenced supply as a company-owned concern in October, 1893, with a number of small Laurence-Scott sets) now comprises two 420-kw. and one 500-kw. Willans-Siemens sets, a 750-kw. Crompton-Belliss set (these 4 units being the ones flooded); a 1,000-kw. Parsons turbine and a 600-kw. Willans-Siemens mixed-pressure turbo set. The Belliss set was installed after the Parsons unit, reversion to engine drive being attributable to the more or less experimental nature of turbine plant at that date, and to the great length of space required by the latter prior to the introduction of the disk and drum turbine.

A 2,000-kw. Howden turbine is to be completed this autumn, and the old reciprocating sets will be replaced by turbines as further extensions are required. In case of necessity, the power house can be extended towards the coal yard, thus providing sufficient accommodation for all the plant ever likely to be required.

The supply is on the 220/440-volt three-wire d.c. system, the turbines driving dynamos in tandem. Although a considerable factory load is supplied (nearly 4,000 h.p. being connected), there is no probability of high-tension three-phase generation being adopted for industrial purposes, since the consumers, including Messrs. Colman (350 kw.) and a number of boot factories, lie close to the supply station.

The original five single-drum water-tube boilers (each evaporating 5,000 lb. per hour) are now doing useful work at a neighbouring beet sugar factory, and are replaced at the central station by two double drum boilers, each of 25,000 lb. per hour evaporative capacity. Two B. and W. boilers of 8,000 lb. per hour capacity complete the equipment of the riverside boiler house. At the other side of the engine room is a second boiler house containing four Lancashire boilers each of 5,000 lb. per hour capacity and one marine type water-tube boiler evaporating 28,000-30,000 lb. per hour.

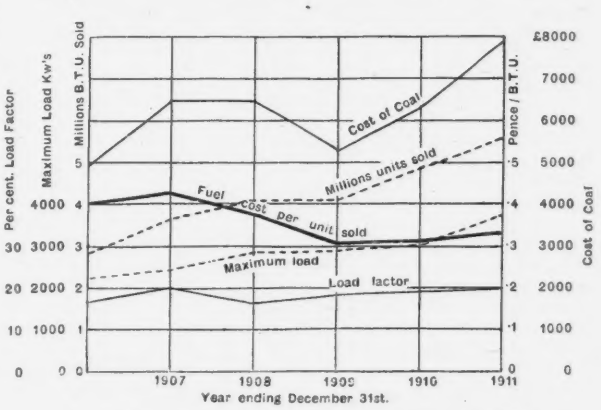
The riverside boiler house is being provided with overhead bunkers holding 500 tons, with gravity feed to the chain grate hoppers. A conveyor system is also being erected to connect with the riverside coal yard where 1,000 tons of fuel can be stored. The present winter coal consumption reaches 250 tons per week, so that the station will have about six weeks' fuel storage capacity. During the coal strike last spring, the stock-in-hand fell from 1,058 tons on March 8th, to 771 tons on April 8th, and 197 tons on May 6th, after which a large shipment was received by water; full supply was maintained throughout.

The present 18-in. condenser water intake from the river is to be replaced by a 36-in. sq. intake-culvert, work on which is now in progress. At the outer end of the intake, a Brackett screen is to be employed. This consists of an endless band of $\frac{1}{8}$ in. mesh phosphor-bronze netting running over top and bottom drums; all but the smallest *débris* is arrested, and that which clings to the netting is washed off by outward jets of water near the top drum, into a trough discharging down-stream. In addition to the usual trouble caused by inanimate *débris*, many eels have been drawn through the centrifugal pumps into the condensers, and a number have actually lived and grown in the coolers, &c. It is hoped that the new screen will largely prevent the ingress of organic spores (carried by slime washed out of barrels in a brewery above the station), which in the past have rapidly collected and grown in the condensers, necessitating weekly cleaning of the tubes.

A new battery of 224 Premier cells, having a discharge capacity of 980 amperes for three hours, 2,100 amperes for one hour, and 3,600 amperes momentarily, has recently been installed in a three-story accumulator house opening off the engine room. The walls of this building are of ribbed steel enclosed in 3-in. thickness of a plaster, through which the recent flood water easily percolated. At one time the water was half way up the cell boxes on the ground floor, but the cells were not damaged.

The new offices adjoining the works are nearing completion. At a cost of £3,000, a very handsome block has been erected, providing accommodation for the clerical staff, the wiring, meter, mains and the lighting staffs, and including showrooms, electric cooking demonstration rooms, and various work and repair shops. The whole of the old buildings will be used as stores.

The general progress of the undertaking is graphically illustrated below. During the quarter ending June 30th the



Curves showing the Progress of the Norwich Electricity Department.

average fuel consumption was 3·52 lb. per unit generated, or 3·95 lb. per unit delivered to the mains, while the boilers averaged 13·5 cwt. per 1,000 gallons of water evaporated.

Two-thirds of the streets are now lighted electrically, and the remaining gas lamps will be converted as soon as possible. The expenditure involved is being met from the revenue, and it is expected that £1,000 per annum will be saved when the conversion is completed. Single lamps are employed on

most of the standards (which have graceful swan necks and simple but efficient white-enamelled top reflectors and no lanterns). More than half the total number of lamps are 50-c.p. units; only 27 100-c.p. metal lamps are used, the remainder being of 75 c.p. each. In addition to 16 10-ampere open arcs along certain of the tram routes, there are nearly 1,200 metal lamps in use for public lighting.

By far the most interesting feature of the private supply is the remarkable popularity and efficacy of the assessment tariffs in vogue. Alternative to a flat rate of 4·5d. per unit, a consumer may pay 12 per cent. per annum on the rateable value of his house and is then supplied at 1d. per unit, flat rate. Two years ago about 47 per cent. of the total lighting sales were at 1d. per unit, and at present nearly 60 per cent. of the total are thus sold. This is a remarkable result when it is remembered that the total costs per unit sold are about 0·90d. (average revenue per unit sold = 2·1d.). The capital burden is high (£82·16 per KW.), and will be temporarily increased by the present extensions, but a handsome surplus has been secured during recent years. The introduction of the metallic-filament lamp was beneficial rather than unprofitable to the station.

Special tariffs have been designed for very small consumers. If the rateable value of a house is less than £10 per annum, free wiring and lamp renewals are offered at, say, 30s. per annum for six lamps, and current is supplied at 1d. per unit flat rate. The smallest consumers are supplied at 1s. per lamp per quarter (or even smaller fixed charges for wiring and lamp renewals), and 1d. per unit for current. Shop lighting is charged at 1d. per unit plus an annual charge, which varies from £10 to £7 per KW. of maximum demand, according to the size of the installation.

Our best thanks are due to Mr. F. M. Long, city electrical engineer, and Mr. Austin, assistant engineer, for their kind assistance in explaining the working of their station and the circumstances and effects of the flood—from the after-effects of which we wish them a speedy recovery.

TRAMWAY and RAILWAY NOTES.

(*Continued from page* 418.)

Belfast.—The extensions of the tramway system on the Oldpark Road, Ravenhill Road and Donegal Road are now well forward and only require linking up with the existing tramways with which they will connect. It is expected that all the extensions will be in running order by the end of the year.

Birkenhead.—It was reported at a meeting of the Corporation on September 4th, that the B. of T. had given sanction to the borrowing by the Council of £4,374 for the purchase of six new tramway cars for service on the New Ferry route between Woodside Ferry and Port Sunlight. The contract has been placed with Messrs. Siemens Bros. Dynamo Works, Ltd., for supplying and delivering six double-bogie cars (with bodies built by Messrs. Hurst, Nelson & Co., Ltd.), each to seat 60 persons.

Bournemouth.—A poll of ratepayers is to taken on the question of running a Sunday afternoon and evening tramway service.

Burnley.—The Tramways Committee has received a letter from the B. of T. certifying Harle Syke Tramway fit for public traffic, and that a goods wagon attached to passenger cars could be used for a period of three months, at the end of which time a report was to be furnished on its working.

A deputation from the National Motor-Carriage Insurance Union attended with reference to the decision to run the goods wagon, and requested the Corporation to abandon the scheme on the following grounds:—(1) That the Corporation were thereby competing with ordinary carriers; (2) that it was dangerous to drivers of ordinary vehicles and to the public generally; and (3) that there were already sufficient vehicles using the roads. The Committee adhered to its decision, and fixed the charges for the conveyance of goods.

In view of the continued growth of the tramway traffic, the Tramways Committee proposes to purchase five new top-covered cars, at an estimated cost of £3,900.

Canada.—The Montreal City Council has received an application from the Comptoir Financier Franco-Canadian for permission to construct a system of underground electric railways. It is claimed that the capital will be furnished by Parisian bankers, and that Parliamentary powers are to be asked for in order to carry out the project. The present company is only a preliminary one, it being proposed to form a concern with $100,000,000 capital as soon as the necessary authority can be obtained. The trains will consist of five coaches, one of first-class and four of second class, each coach holding about 110 passengers. Plans are being drawn up by Parisian engineers. The Council has decided to await the full organisation of the company before taking action.

Preparations for the construction of the Mount Royal tunnel for the C.N.R. are being made, although the plans for electrification have not been prepared. Two 400-H.P. and four 200-H.P. electrical air-compressing plants for pumping and drilling, &c., are being supplied, and five contractors' electric locomotives have been purchased. The tunnel will be 3¼ miles long, and about 8 miles of route will be electrified.

Continental Notes.—Austria.—The Secretary of State for railways is negotiating for the electrification of the Arlberg line from Landeck to Bludenz. The estimate of cost for the electrification, exclusive of the power station, amounts to 11,000,000 kronen, while 15,000,000 kronen is set aside for the erection of the power station.—*Financial News.*

Germany.—A railway line much used by tourists in the Bavarian Alps—namely, that running from Salzburg, through Freilassing and Reichenhall to Berchtesgaden, is to be electrified. The work has been entrusted to the Siemens-Schuckertwerke, of Berlin. The poles are being erected, and the installation of the overhead lines will be begun in a few weeks. It is not intended to relay the metals.—*Elekt. u. Masch.*

Among the several new electric railway schemes projected recently are one from Frankfurt-on-the-Main, through Kronberg to Königstein, the Lokalbahn A.G. being the promoters; the Cologne to Bonn and the Cologne to Düsseldorf lines, for which and other works the T.C. of Cologne has just approved a loan of £3,950,000; a line from Lützelburg (Alsace-Lorraine) to Dagsburg and Wangenburg, promoted by the "La Houve" mining company, of Strassburg; a line from Neuss (Rhine Provinces) to Rheydt, with branches to Holzhain and München-Gladbach, the joint concern of the several towns named; a line from Offenbach (Hesse) to Isenburg, Sprendlingen and Egelsbach, the A.G. für Bahn-Bau und Betrieb being the concessionaires, and the municipal station at Offenbach furnishing the current; and a line from Wilstedt to Zeven and Tostedt, estimated to cost £165,000; also two electric tramway schemes—one from Darmstadt to Offenbach, promoted by the Hessischen Eisenbahn A.G. and the A.G. für Bahn-Bau und Betrieb, and another in the town of Insterburg, in East Prussia, for the construction of which the A.E.G. are in treaty with the municipal authorities.—*Elektro. Zeitschrift.*

Among the locomotives furnished for the Dessau-Bitterfeld electrification is a high-speed locomotive made by the Bergmann Electricity Works. This locomotive has a two-axle pony truck at the front, two driving axles with wheels of 63 in. diameter in the middle and a trailing axle at the rear. The transmission system is operated by a single-phase series motor, the speed control and reversal of which is obtained by shifting the commutator brushes. The motor is rated at 1,500 H.P. at 270 R.P.M., which corresponds to a locomotive speed of 49·6 M.P.H. During trial trips, however, a speed as high as 77·5 M.P.H. was attained. In practice, the locomotive has had no difficulty whatever in hauling passenger trains weighing more than 400 tons at the required speed, and freight trains weighing almost 1,000 tons have been hauled at 34·1 M.P.H. The normal drawbar pull is about 9,900 lb. with a maximum of 34,100 lb. when the locomotive is at a standstill. The total weight of the equipped locomotive is 72 tons. The motor weighs 15 tons and the transformer 7·6 tons.

Messrs. Brown, Boverie & Co., of Mannheim, are reported to have received an order from the Prussian State Railways for the delivery of 10 single-phase locomotives, each of 1,200 H.P., for the Lauban-Konigszelt railway.

France.—The French State Railway authorities, who have been engaged for some time past in making trials in connection with the introduction of electric traction on the nationalised Western Railway, have just placed an order for 100 motor coaches and 400 trailers with French and Belgian works. It is stated that the motor coaches are to be equipped with apparatus to permit of the automatic coupling of the coaches forming a train.

Russia.—In amplication of the information given in our last issue regarding the railway to be built from Riga to the seaside resort of Majorenhoff, it is stated that the concession has been granted after the Riga Tramways Co. had been included in the consortium, and that the line will be on the single-rail system, electrically worked. A generating station is also to be built, a distributing network erected, and an iron bridge built over the Aa River. The whole installation must be in working by 1917. The constructional works will be in the hands of the Riga Tramways Co. —*Elekt. u. Masch.*

Dewsbury.—At a meeting of the Birstall and District Chamber of Commerce, on the 5th inst., a protest was made against the increase of tramway fares in the Yorkshire Woollen district, and at the Dewsbury T.C. the same evening it was stated that all the neighbouring authorities were supporting Dewsbury in its action against the local tramway company's methods. It was said that altogether the company had raised the fares 50 per cent., which was considered outrageous, while it was alleged the system was one of the best paying the company had.

The B. of T. has extended the period for the commencement of the work in connection with the Shaw Cross tramways until August 18th, 1913, and the completion until August 18th, 1914.

Doncaster.—It has been decided to obtain, in time for the monthly meeting in October, tenders for the light railway extensions at Bentley which were authorised by the Doncaster Corporation Light Railways (Extension) Order, 1911.

Dundee.—After inspection on behalf of the B. of T., the railless traction system was opened for traffic last week. The route is along Clepington Road, at the east end of the town, and connects the terminus of the Maryfield section with the line at the Fairmuir, being a mile and a quarter in length. The cars, of which there are two, have been supplied by the R.E.T. Construction Co., London

Elland.—On the 6th inst. there was a conference between the D.C. and the Halifax Tramways Committee to discuss the proposed extension of the Halifax system to Elland. The members were not unanimous on the granting of a subsidy of £100 a year for four years, or upon the route. It was stated, however, that the Woodside route would probably be approved. This route will cost, with a double line all the way from Calder and Hebble to Elland, near Hull, over £20,000, while the route from West Vale with single track would cost only about £8,000. The Elland Council has ratified its promise made in February last to the Huddersfield Corporation to grant a subsidy of £500, to be extended over a term of five years and subject to the ratepayers' consent, if the Huddersfield tramways system was extended from Birchencliffe to Elland.

Glasgow.—The T.C.'s Committee on Tramways has decided, by a majority of five, to recommend the Corporation to approve of a proposal to remit to a special Sub-Committee to consider and report as to the desirability and practicability of the tramways department providing cottage dwellings to be rented by workmen in the service of the department.

London.—In connection with the collision which occurred at the Caledonian Road tube station of the Great Northern, Piccadilly and Brompton Railway last week, a B. of T. inquiry was opened on September 9th. The collision occurred through a non-stop train running into the rear of a train which was standing in the Caledonian Road Station, and the inquiry turned on the behaviour of the automatic signalling system. Evidence was given showing that the signal in question had once failed, but had then gone to danger (as it should have done in such a case). Further evidence as to the trip cock under the motor coach (which should automatically apply the brakes) disclosed nothing unusual, and the inquiry was eventually adjourned until the driver of the colliding train is sufficiently recovered to give evidence.

The Metropolitan Electric Tramways Co. is introducing some 300 Daimler buses, to supplement its tramway services on the roads of North London.

U.S.A.—According to the *Railway and Engineering Review*, the New York, N.H. and H. Railway, which has recently placed an order for 39 additional electric locomotives for combined goods and passenger service, will soon have a total of 106 heavy electric locomotives in service. The original locomotives had a maximum tractive effort of 19,200 lb., but in the more recent ones this has been increased to 40,000-45,000 lb. Some 16 switching locomotives, having a tractive effort of 39,500 lb. and weighing 80 tons each, have been introduced for use in the freight yards.

Wakefield.—The solicitors to the Yorkshire (West Riding) Electric Tramways Co. have written to the Council to the effect that the company were unable to raise capital for the construction of the lines not already constructed, as authorised by the Wakefield and District Light Railways Orders, 1901-2 (it will be remembered that the Yorkshire (West Riding) Electric Tramways Co., Ltd., took over the Wakefield undertaking some little time ago), and suggested that if the local authorities concerned in the extensions could arrange to construct the lines, the company would be prepared to work them. A Sub-Committee of the Corporation arranged to confer with the Stanley and Ardsley East and West Urban District Councils, and, after an interchange of views, the representatives undertook to take the instructions of their respective Councils, and communicate with the Corporation prior to a suggested interview with the directors of the company.

TELEGRAPH and TELEPHONE NOTES.

Admiralty.—The Admiralty has acquired seven acres of land at Stockton for the purpose of a wireless telegraph station.

Canadian Telegrams.—As the result of representations made to the Western Union Telegraph Co. by the Postmasters-General of Great Britain and Canada, the following reductions will be made at an early date in the rates for telegrams in plain language transmitted by that company and its associated companies between the United Kingdom on the one hand and Canada and the United States on the other hand:—

The present rate of 6d. per word for telegrams subject to a possible delay of 24 hours will be reduced to 4½d. per word, and the telegrams will be transmitted and delivered subject only to such delay as is necessary to give priority to ordinary traffic at 1s. per word. A new service of night letters will be brought into force at a charge of 3s. for 12 words and 2½d. for each additional word. These telegrams will be delivered, subject to the prior delivery of ordinary traffic, on the morning of the day following that on which they are handed in.

The present rate of 6s. for 30 words and 1s. for each additional group of five words for week-end cable letters handed in up to Saturday night for delivery on the following Tuesday will be reduced to 4s. 6d. for 24 words and 2½d. for each additional word, and the telegrams will be deliverable on the following Monday.

A reduced rate of 3½d. instead of 5d. for ordinary Press telegrams has already been brought into force, as well as an improvement in the conditions on which Press telegrams at the rate of 2½d. per word are transmitted and delivered. The latter telegrams have hitherto been subject to a delay of 19 hours reckoned by the clock time of the country of destination. They are now transmissible during the hours from midnight to 6 a.m. in the country of origin, and also during the hours from 6 to 9 p.m., Greenwich time, corresponding to 1 to 4 p.m. Montreal or New York time.

These rates apply to those places in the East of Canada and the United States to which the rate for ordinary telegrams is 1s. per word. The rates chargeable to other places both in Canada and the United States are being correspondingly reduced.

Germany.—The Gesellschaft für drahtlose Telegraphie has erected a wireless station on the roof of its offices in Berlin, with a range of 1,000 km.

Imperial Wireless.—The British wireless station will be erected near Carnarvon. The receiving station will be at Nebo, and the transmitting station some miles to the north.

Pacific Cable.—The accounts of the Pacific Cable Board were published last week; they show that the traffic receipts for the year ending March 31st, 1912, were £159,051 gross, £154,892 net, making, with £3,986 received for the charter of the *Iris*, and minor items, a total of £159,150. The excess of receipts over expenditure was £37,046, which goes towards meeting the annuity of £77,544 for interest and sinking fund on the capital outlay of £2,000,000. This surplus is £7,712 more than that of the previous year, and reduces the sum to be provided by the Imperial and Dominion Governments to £40,498. The net traffic receipts increased by £18,749. Expenditure increased by £12,761, of which £7,339 was due to the payment of a full year's rent for the land line, as against four months only in the previous year. A surplus of over £40,000 is expected for the current year. The renewal fund stood at £286,289 on March 31st; the cost of the new Australia-New Zealand cable will be met out of this account. The cable suffered no interruption during the year. The adoption of a contrivance for magnifying the signals on the long sections on either side of Fanning Island, due to Mr. E. S. Heurtley, aided accuracy of transmission and increased the speed by as much as 25 per cent.; a royalty of £1,000 a year, increasing to a maximum of £1,500, is paid for the use of the instrument.

The new cable will complete the triangle Norfolk Island-Australia-New Zealand, thus duplicating the two southern sections and providing a short route for inter-colonial traffic, and at the same time saving £6,000 per annum; the total cost of the addition is expected to be under £175,000. The principal contracts were placed with the India-Rubber, Gutta-Percha and Telegraph Works Co., Ltd., and Messrs. Siemens Brothers & Co., Ltd., and it is hoped that the cables will be laid and in operation before the end of 1912. The Canadian land-line has continued to give satisfaction, and improvements in its working are in progress. Difficulties were experienced in maintaining communication by steamship with Fanning Island, owing to the exigencies of the mail service between Canada and New Zealand, which no longer allowed of the mail steamers visiting the island. Since August last year only occasional calls have been made, by special arrangement, and it is uncertain what will be done in the future. The result has been that the Board has been put to much expense and anxiety, and the staff on the island to much inconvenience, discomfort, and even risk of health. To mitigate the trying conditions of life on the island, refrigerating plant has been installed, and electric lighting will be substituted for the present system of illumination by oil lamps this year. New offices are being obtained in Sydney at a cost of £10,000. The deferred-rate system, which came into force in January last, has proved very satisfactory, the number of words carried in three months being 46,450, while the ordinary traffic also increased. The reduction of rates for deferred Press messages made in December last led to no increase in the total volume of Press traffic, about half of which was merely transferred to the deferred class. The total of international messages carried last year aggregated 2,131,376 words.

Norway.—Marconi's Wireless Telegraph Co., Ltd., has entered into a contract with the Norwegian Government for the erection of high-power stations in Norway and the vicinity of New York, for the purpose of conducting a commercial telegraph service between Northern Europe and America. The receipts of the joint stations will be pooled by the Norwegian Government and the Marconi Wireless Telegraph Co., of America, and divided equally between them. Marconi's Wireless Telegraph Co., Ltd., receives the sum of £70,000 for the Norwegian station, exclusive of site, foundations, and buildings, and 10 per cent. of the gross receipts. The contract is for a definite period of 25 years, at the end of which time the Norwegian Government has the right to renew it. The stations will be erected as quickly as possible and must be completed within 12 months of the foundations and buildings being ready.

A Roumanian Wireless Invention.—Two Roumanian military officers, Captain-lieutenants Dan Zaharia and Gustav Rötlander, have invented a novel wireless receiving apparatus, more especially adapted for flying machines, which weighs only 270

grammes. Tried on aeroplanes, the apparatus has given the best results.—*Elek. und Masch.*

Suffragist Outrage.—On August 31st 14 important trunk telegraph wires were cut on the London Road near Potter's Bar, and a notice was affixed to a post stating that the damage which had been done was entirely owing to the attitude of the Government towards suffragists. Great inconvenience was caused to the telegraphic service in consequence of this malicious act.

U.S.A.—The Navy Department is seeking powers from Congress to establish a wireless telegraph system which will enable it to keep in touch with its ships in all parts of the world.

On August 16th President Taft approved the Bourne Bill regulating radio-communication. This Act requires every person, company or corporation within the jurisdiction of the United States operating any apparatus for commercial radio-communication among the several States, or with foreign nations, to obtain a licence from the Secretary of Commerce and Labour. All commercial wireless apparatus while in use shall be under the supervision of the Secretary of Commerce and Labour. The Act provides that the normal sending and receiving wave of each station shall have a definite length, either not exceeding 600 m. or exceeding 1,600 m. All ship stations, and all coast stations open to general public service, shall be prepared to use two sending wave-lengths, one of 300 m. and one of 600 m. Shipboard stations when within 15 nautical miles of a naval or military station shall not use a transformer input exceeding 1 KW., and when within 5 nautical miles the input shall not exceed ½ KW., except for distress signals. In general, wireless stations must not use more energy for transmission than is necessary. Penalties are provided for a violation of any of the regulations contained in the new Act, which was passed by the House of Representatives on August 9th, and was apparently enacted without any consideration of the Wireless Convention signed at London by the delegates of some 30 nations early in the month of July.—*Electrical World.*

Wireless for Troopships.—The Government of India has sanctioned the immediate installation of wireless telegraphy on the R.I.M. steamers *Dufferin*, *Hardinge* and *Northbrook*, and these vessels are now being fitted at the Government Dockyard, Bombay. The cost of installation is 16,000 rupees for each ship, and Mr. Parker, special officer in charge of wireless telegraphy, is supervising the work.

Wireless on Airships.—At the request of the Army Council, the Admiralty invited four naval wireless telegraph operators to volunteer for service in the military wing of the Royal Flying Corps, for the period of the Army manœuvres, to work the wireless telegraph equipment fitted to the airships taking part in the manœuvres.—*Daily Telegraph.*

Wireless on Board Ship.—A Bill to impose compulsorily the adoption of wireless telegraphy on certain classes of ships has been prepared by the Board of Trade in consultation with the Post Office and the Admiralty, but as the question is one on which international agreement is desirable, it is to be deferred until after the proposed international negotiations on Safety of Life at Sea.

CONTRACTS OPEN and CLOSED.

OPEN.

Australia.—New South Wales.—September 25th. Trunk line switchboard, for the P.M.G.'s department. See "Official Notices" August 23rd.

October 2nd.—N.S.W. Government Railways. Six 1,000-KW. sub-station units to specification No. 357. Specification (10s.) from Electrical Engineer's Office, 61, Hunter Street, Sydney.

October 16th.—N.S.W. Government Railways. Two 5-ton electrically-driven travelling cranes, for the Randwick workshops. Specification No. 365 (5s.). Electrical Engineer's Office, as above.

South Australia.—October 1st. Telephone switchboards at Unley, Adelaide, for the Postmaster-General's department. See "Official Notices" August 23rd.

October 1st.—Telephone switchboards at Norwood, for the P.M.G.'s department. See "Official Notices" August 23rd.

October 22nd.—Telephone switchboard at Port Adelaide, for the P.M.G.'s Department. See "Official Notices" to-day.

October 23rd.—100 common-battery table telephones, for the P.M.G.'s Department. See "Official Notices" to-day.

Victoria.—September 17th.—One fuel economiser, for the Melbourne Corporation electricity works.

October 2nd.—Two vertical sets of electrically-driven rotary pumps, for the Melbourne City Council. See "Official Notices" August 16th.

October 22nd. Fourteen sections of common-battery multiple switchboard, for the P.M.G.'s department. See "Official Notices" to-day.

Western Australia.—November 5th. Telephone switchboards to Stores Schedules 222 and 223, for the P.M.G.'s department, Perth. See "Official Notices" to-day.

Austria.—Vienna.—November 30th. Plans are required for the erection and operation of an electrically-worked municipal central clock installation. Particulars, Magistratabteilung V, Vienna.

Trieste.—September 23rd. Twelve cranes of 1,500 kg. capacity are required for the Molo della Sanità. Half must be delivered complete ready for erection within 6, and half within 12 months. Particulars of the Technische Abteilung der k.k. Lägerhauser, Trieste.

Birmingham.—September 19th. Supply of 167,000 tons of coal to the generating stations of the Corporation electric supply department. Mr. R. A. Chattock, city electrical engineer and manager.

Bulgaria.—October 17th. The District Administration of Finances in Sofia is inviting tenders for the supply and erection of the mechanical and electrical plant required in connection with the power transmission installation to be laid down at the State collieries at Pernik.

Costa Rica.—December 9th. Tenders are invited for the building and working of an electric tramway between Alajuela and Grecia, a distance of 18,100 m. Particulars from the Secretaria de Fomento, San José.

Dundee.—September 23rd. Electric lighting at Carolina Shed, for the Harbour Trustees. Particulars from General Manager of the Dundee Harbour Trust.

Grimsby.—September 16th. Automatic balancer for the Corporation. See "Official Notices" September 6th.

Hungary.—The municipal authorities of Nagyteteny and Szekelyhid have just invited tenders for the establishment of central electric lighting stations in their respective towns.

Large Conduit Order.—One million feet of conduit, with accessories. See "Official Notices" to-day.

Leeds.—October 7th. The Tramways Committee of the Corporation invites tenders for the supply and erection of a steel building at the permanent way depôt, Leeds. Mr. J. B. Hamilton, general manager.

London.—L.C.C.—September 24th. Electric spark gaps in brick cells for sub-stations. See "Official Notices" August 23rd.

Hammersmith.—September 25th. A.C. motors, for the Corporation. See "Official Notices" to-day.

Lossiemouth.—September 28th. Gas producer plant, engines and dynamos, battery, crane, overhead mains and public lamps, for the T.C. See "Official Notices" September 6th.

Manchester.—September 18th. Electric lighting of Crumpsall Workhouse, for the B. of G. See "Official Notices" September 6th.

Mexborough.—October 5th. Turbo-generator, condenser and switchgear, for the U.D.C. See "Official Notices" to-day.

Newcastle-on-Tyne.—September 18th. Electric light installation at the Cottage Homes, Ponteland, for the B. of G. Mr. G. Walker, clerk, 127, Pilgrim Street.

Newport (Mon.).—September 17th. Coal for the Corporation electricity department for a year. Mr. N. J. Young, general manager, Town Hall (returnable deposit of 10s. 6d.).

September 18th.—Extension of plant at the Corporation electricity works: Railway weighbridge, ash conveyor and bunker, water-tube boiler, flues, and forced and induced draught plant. See "Official Notices" September 6th.

Rosario.—October 15th and September 21st. According to the *Review of the River Plate*, the Municipality is calling for tenders, until October 15th, for a second system of electric tramways, including their construction and working. Full particulars from the Municipality. Tenders for the public electric lighting will be opened on September 21st.

Roumania.—The municipal authorities of Botoschani are reported to be about to invite tenders for the concession for the supply of electrical energy for lighting and power purposes in the town.

South Africa.—For the electric lighting of Cradock, Cape Colony, some £10,000 worth of machinery and apparatus will shortly be required.

Ventnor.—The U.D.C. has under consideration a scheme for the construction of a passenger lift from the Esplanade to the town, worked by electricity.

West Hartlepool.—September 14th. Steam, exhaust and other pipework, for the Corporation Electricity Department. See "Official Notices" September 6th.

CLOSED.

Argentina.—In connection with the electrification of the suburban railway lines in and about the city of Buenos Ayres, a contract, which is probably the largest ever placed for an electric cable installation, and certainly the largest for extra-high-tension cables, has recently been placed by the Central Argentine Railway, Ltd., with W. T. Henley's Telegraph Works Co., Ltd., of Blomfield Street, London, E.C. The contract, which covers the supplying and laying of all the underground power cables that the undertaking requires, will take about 18 months to complete, and will necessitate the sending out of a number of engineers, foremen, jointers, &c., to carry out the work of laying and jointing. The principal item is one of 66,000 metres of 1 sq. in. paper-insulated, lead-covered and armoured three-phase cable for a working pressure of 20,000 volts, which is to be laid directly in the ground. The laying of this cable will necessitate several hundred joints, which will be made in cast-iron sleeves filled with compound under vacuum. As may be imagined, very stringent tests are specified for the cables both before and after laying.

In addition there is a length of 66,000 metres of three-core pilot cable, and 28,000 metres of armoured telephone cable, which will also be laid direct in the ground. The contract also includes 20,000 metres of 1·0 sq. in. paper-insulated and vulcanised bitumen sheathed track cable, to be laid solid in troughing. The track cable referred to will be used for feeding the conductor rails and running rails, and for connecting across breaks in the rails at level crossings, junctions, &c. Track pillars to the number of 1,300 are to be supplied by the contractors, together with a large number of joint boxes and a considerable amount of telephone apparatus, &c.

The consulting engineers are Messrs. Livesey, Son & Henderson, 14, South Place, E.C., and Messrs. Merz & McLellan, of Westminster and Newcastle.

We may add that this important contract was secured in competition with British and Continental manufacturers.

Belgium.—Five concerns competed for the contract for the electrical equipment of a transformer sub-station at Dieghem in connection with the Société Nationale des Chemins de Fer Vicinaux's light electric railway between Brussels and Haecht. The lowest offer was that of the Société des Ateliers de Constructions Electriques, of Charleroi.

Bradford.—The tender of the British Westinghouse Co. for the supply of a 1,500-KW. rotary converter, for £3,978, has been accepted by the Corporation.

Bristol.—The City Council has accepted the tender of the British Insulated and Helsby Cables, Ltd., at £539, for an annual supply of electricity meters (watt-hour type, for alternating current).

Canada.—A Canadian contemporary states that Messrs. Siemens Bros. Dynamo Works recently obtained contracts for a 400-KW. direct-current generator for direct-coupling to a Belliss engine, for the city of Regina; also a 2,000-KW. three-phase generator for coupling to a Willans turbine, a 750-KW. direct-current generator for coupling to a Belliss engine, and a 425-H.P. three-phase motor, for the city of Edmonton.

Dundee.—The General Electric Co., Ltd., recently supplied the Corporation with 88 "Angold" magazine flame arc lamps for replacing the old open-type arcs hitherto used for street lighting in that town. It was necessary to have the installation completed for the opening meeting of the British Association, and no delay occurred anywhere; delivery was effected on time, all lamps were tested, and the entire change-over from old to new lamps was made without a hitch in one day.

Glasgow.—The Tramways Committee recommends the T.C. to accept the offer of the St. Helens Cable and Rubber Co., Ltd., for trolley feeder cable.

Keighley.—The Education Committee of the T.C. has accepted the tender of Messrs. Longbottom & Farrar for electrical fittings for the new Highfield School, at £39.

Leeds.—The Corporation has ordered two pairs of chain-grate stokers for B. & W. boilers from Messrs. Ed. Bennis & Co., Ltd. (repeat order).

London.—Amongst the contracts for power and lighting which are being carried out by Messrs. G. Weston & Sons, Ltd., are Messrs. Danneman's piano factory, Islington; Messrs. Pearks's factory, Stoke Newington; the Mitcham Margarine Co.'s works, Mitcham; and Messrs. Wheen & Sons' soap factory, Deptford.

Manchester.—Referring to our note last week, we are informed that Messrs. Wm. Geipel & Co. received the order for six of the seven sizes of time switches required by the Corporation.

Newcastle-on-Tyne.—A contract has been entered into with the British Westinghouse Co. for electrical plant and switchgear for the Corporation tramways power and sub-stations, at £6,817.

Stockport.—The T.C., on September 4th, accepted the following tenders:—

Lancashire Dynamo and Motor Co., Ltd., 170-K.V.A. alternator, £1,018; Ferranti, Ltd., high-tension switchboard, £72 10s.; Naylor Bros., Ltd., 100 lattice poles for tramways, £6 each.

Wallasey.—The Corporation has accepted the following tenders for supplies:—

Messrs. Sykes & Sugden, Ltd.—Boxes and switches and cut-outs.
Messrs. Alfred Hopps & Sons, Ltd.—Cylinder and lubricating oils.
British Insulated and Helsby Cables, Ltd.—Cable, boxes, &c.

FORTHCOMING EVENTS.

North-Eastern Counties Electrical Exhibition.—Open daily to Saturday, September 28th inclusive. At the Exhibition Hall, St. Mary's Place, Newcastle-on-Tyne.

Hardware, Ironmongery and Oil Engineering Exhibition.—Open daily to Tuesday, September 17th inclusive. At Olympia, London, S.W.

NOTES.

Inquiry.—A correspondent desires to find an English market for electric cookers and hot-plates, and will probably be able to place a large order for export.

Electrically-Illuminated Aeroplanes.—On September 26th an exhibition of night flying will be given at Hendon, when each aeroplane will carry a searchlight, with side and rear lights, and will be otherwise illuminated by electric lamps supplied from accumulators carried on the machine. Searchlights to guide the aviators and other ground illuminations are also to be features of the display.

Copper.—Statistics of this market, from Messrs. Merton's circular for August, do not show a particularly brisk demand, probably owing to the rise in price. The European visible supplies have, as a whole, increased during the month by 640 tons, the second time an increase has been shown since September, 1911. English stocks have increased 930 tons, and French 410 tons; the quantity afloat from Chile is 300 tons less, and from Australia 400 tons. Rotterdam stocks, at 570 tons, are 180 tons less, and Hamburg 702. If the Dutch and German stocks are included, therefore, the supplies are less for the end of August by 242 tons. The supplies from North America are rather below average at 25,660 tons, the average being 27,949 tons. Spain and Portugal are over double the average, with 3,740 tons; Chile shipments are also high, as well as Australian. The total deliveries, at 42,320 tons, are just above the average, but considerably below June and February. American stocks for the end of July show an increase of 2,653 tons over the return for June. The total visible supply for the end of July showed an increase of 5,089 tons over the preceding month.

The Manchester Rails Contract.—The following interesting letter appeared in the *Morning Post* of Saturday last:—

"There is a great deal more involved in the preference given to an American firm by the Manchester City Council in the contract for steel rails, described in your issue of the 5th instant, than the immediate loss of over £10,000 to British industry. The incident will be freely and very properly used as an advertisement not only by the individual firm directly interested in it, but by others engaged in similar industries, certainly in China and Japan, and no doubt also throughout the Latin States of South America, it may be even in our own Australian and Cape Colonies. Pamphlets will be drawn up in the Chinese and Japanese vernacular languages and freely circulated by active agents on the spot among all buyers, in which the transaction will be fully described and emphasis laid on the statements in the debate in the Council that the American product is fully equal in quality to that of the best Sheffield firms, and is at the same time both substantially cheaper and more quickly delivered. Speedy delivery is of the essence of all contracts for public works, and if an American firm in Pennsylvania can deliver goods in Manchester more speedily than an English firm in Sheffield, how much greater will be the advantage of dealing with the former when the delivery has to be made either in the Far East or in South America! These points will be urged by agents who are, as a rule, not at all scrupulous in using unfair arguments, and will make the most of these which are perfectly honourable and are provided by ourselves. The ultimate results may be not a loss of £10,000, but of many tens, even hundreds, of thousands of pounds and a permanent injury to British industry.

I can remember very well the use that was made, both in Japan and China, of the contract for the Atbara bridge in Egypt, which was given by the India Office to an American firm in the late nineties of the last century, and it is my memory of that time which now induces me to submit to you that such actions on the part of British public bodies have more than the parochial results of one comparatively insignificant loss. The Atbara contract was then defended in the House of Commons in similar terms to those that have just been used in the Manchester City Council. Every word of the defence was fully translated into Japanese and Chinese and widely circulated, both in pamphlets and in advertisements and articles in the native Press, and no expense was spared by American agents in securing the widest publicity to the fact that the superior efficiency of American to British steel foundries was admitted in the most convincing way in England. I pointed this out, as fully and as strongly as was compatible with official limits, in my annual Trade Report for the year, but the report was edited in the Foreign Office, and all I wrote on this point was struck out before publication. That was fully 14 years ago, but I cannot recall ever having once seen in the interim the Imperial aspect of this rigid adherence to the cheapest markets mentioned in the English Press.—Yours, &c.,

"JOSEPH H. LONGFORD
"(*formerly H.M. Consul at Nagasaki*).

"Reform Club, *September 6th*."

Fatality.—On Sept. 1st, according to the *Western Morning News*, Thomas John Rule, aged 21, of Hayle, was killed by a live wire near Nancledra, in the St. Ives district. Deceased and other employés were making an examination of the lines between Pendeen and Hayle. At Trenowan Downs deceased ascended one of the poles on the side where the current had not been stopped, and placed his hand on a 6,000-volt "live" wire, causing him to drop to the earth. A comrade hurried to the man's aid, but found him unconscious, and artificial respiration applied for half an hour proved ineffective.

Educational.—University College (University of London).—The new session commences on the 30th inst.

The new session at the Battersea Polytechnic opens on September 24th. See our advertisement pages to-day.

University College, Nottingham.—A notice relating to the department of engineering appears in our advertisement pages to-day.

The Correspondence School of Engineering Mathematics has removed from Bilston to Harley Road, Blackpool.

The E.T.U. in Birmingham.—An attempt is being made to increase the strength of the Electrical Trades Union in Birmingham, where it numbers only 164 members, compared with 330 in Liverpool, 490 in Manchester and 780 in Glasgow.

Appointments Vacant.—Stepney.—Assistant installation inspector (30s.). Manchester.—Shift engineer (£175 per annum). Rathmines.—Shift engineer. Salford.—Meter tester (26s. to 30s.). See "Official Notices" to-day.

A Cracked Arm on a Tramcar Wheel.—In spite of every care on the part of the motorman it not infrequently happens that the car, owing to the speed at which it travels and the unexpected nature of obstacles encountered, sometimes runs over small impediments on the track; but it is very regrettable that this sort of thing happens inasmuch as the shock on the framework of the car, and especially on the wheels themselves, is very considerable. In most cases, the condition of the wheels can be ascertained after an incident of this sort by tapping them smartly with a piece of metal, such as a light hammer, and if there is a dull sound it is extremely probable that the wheel is cracked, while if they ring clearly, damage has been avoided.

In one instance of this nature where a car had run over a somewhat heavy obstacle in the shape of a piece of stone on the track, one wheel appeared from the sound to be cracked, as tested with a point bar. On closer examination, it was found to be cracked at about the centre of the arm. There is no doubt that this could have been run for a long period before anything serious would have happened, but in order to make the matter absolutely secure, it was decided that before the car resumed its journey, a piece of hard timber should be driven between the rim of the wheel and the boss, and this undoubtedly strengthened the wheel. With this provision the car was run for the rest of the day without any further trouble occurring.

When the car was taken home to the depôt it was debated whether the wheel should be withdrawn and a new one substituted, or whether some attempt should be made to repair it, and as only one arm appeared to be cracked, the latter alternative was decided upon. At first it was thought that the best way to tackle the job was to weld the crack electrically, but this would have meant a considerable amount of special preparation, so that eventually a very sound repair was effected by simply rusting the crack with sal ammoniac and iron filings, and although it may not sound as if this would be a strong job, the wheel, as a matter of practical fact, ran for a very considerable period without any further attention.

Copper in Rails.—According to the *Railway News* a new "bull" point for copper which might indicate a largely increased demand for the metal is discussed in the American papers. Recently the engineers of the New Haven Railroad looked into the history of about 6 miles of track that had far outlived the ordinary life and usefulness of the average steel rails, and is still in good condition. They found that this 6 miles of track was laid with rails imported from Glasgow, Scotland. Analysis of the rails showed that, in distinction to the ordinary type of steel rail, they contained about 1½ per cent. of copper. Many of the steel companies, it is said, now have orders on their books for the manufacture of rails containing copper, and an important new use for the metal is on the point of coming into existence.

Wrong Way Valves.—A correspondent points out that there are two ways of making a valve. The one is to make it with a left-hand thread on its spindle so that it closes when turned clockwise, the same as an ordinary household tap, the closing of which is done by that way of turning which employes the more powerful action of the hand. In the other valve the spindle is right-handed and the valve closes by turning the wheel counter clockwise. Now both these valves appear exactly alike, and both are often made without any indication on their wheels or elsewhere that there is any particular direction in which they ought to be turned for opening or closing. If valves of one kind get mixed on a job with valves of the other variety the results may be extremely dangerous. But for a safety valve on a water main such a mix-up would recently have caused very serious damage. Such valves should carry a plain "open" and "shut" indication. That there should be two varieties seems foolish. What reason can be shown for such lack of compliance with standard design? Some firms even make both kinds and yet provide no outward sign of the internal trap ever waiting for an opportunity to ensnare the unwary. This is one of the things that might well form subject matter for the Committee on Standards, for it is a far worse fault than mere difference of dimension.

Artificial Daylight.—According to the *Standard*, a Berlin firm has succeeded in imitating daylight with metal-filament lamps by passing the light through thin semi-transparent sheets of marble in place of glass.

OUR PERSONAL COLUMN.

The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the Electrical Review *posted as to their movements.*

Central Station Officials.—No fewer than 3 members of the staff of the Swansea Corporation Electricity Department have married quite recently, and the blushing husbands (Messrs. D. R. Grey, H. O. Davies, and G. Holdsworth) have each been presented by the rest of the staff with a handsome marble clock. The presentation was made by the borough electrical engineer, Mr. C. A. L. Prusmann, who hoped that the recipients would remain with him for many years to come, and wished them health, wealth, and happiness galore. Their response was both modest and grateful, its keynote being "Fellowship."

Mr. Willmore, late of Tipton, has succeeded Mr. W. D. Jones (who has gone to Australia) as manager of the Wellingborough E.L. Co.

At Tunbridge Wells, on September 4th, Mr. J. W. Beauchamp, late borough electrical engineer, who has been appointed to a similar position at West Ham, was presented with an illuminated address by the members of the Lighting Committee of the T.C. The Corporation officials and the staff of the electricity department also presented a framed photograph of the works staff, and a stand of silver egg cups and spoons for Mrs. Beauchamp, while the wiring contractors of the town handed Mr. Beauchamp a handsome silver inkstand and illuminated address.

Mr. Alfred Wm. Barnett, chief electrical engineer at the Ocker Hill generating station, Tipton, Staffs., was the recipient of a handsome marble clock and side pieces from the staff, on the occasion of his marriage with Miss A. M. Davies on August 3rd.

Mr. J. W. Carter has been appointed meter tester to the electric supply department of the Birmingham Corporation.

Mr. A. A. Harris, of the Coventry Electricity Department, was the recipient of a table lamp and other presents from the staff on the occasion of his marriage to Miss S. L. Owen.

Tramway Officials.—The Bradford Tramways Committee has decided to recommend to the City Council the appointment of Mr. Walter K. Fleming as parcels superintendent in the Tramways Department, in succession to Mr. Hobson. The salary is £200 per annum.

At a meeting of the South Shields T.C. on the 4th inst., Mr. William Tuke Robson, chief assistant engineer of the Hull Corporation Tramways, was appointed tramways manager at a salary of £300 per annum. There were 68 applicants for the position.

General.—Mr. P. Collinson, of Messrs. Collinson Bros., electrical engineers, of Millergate, Bradford, was involved in a very serious motor accident, which occurred on Sunday whilst he was driving between Pateley Bridge and Harrogate. Mr. Collinson escaped any very serious injury, though he is at present confined to his bed; two of the occupants of the car have, however, succumbed to their injuries.

We learn that our friend and contributor, Mr. John D. MacKenzie, Glasgow, was married there on the 5th inst. to Miss M. C. Miller, youngest daughter of the late Robert M. Miller, engineer, Glasgow.

Mr. J. E. Cowderoy, who has recently acted as assistant electrical engineer to the Barking U.D.C., has received an appointment under the General Electrical Co., of London.

Mr. E. J. Barker, who has for nearly 15 years been assistant engineer to the Liverpool District Lighting Co., has resigned, and joined the firm of F. B. Hellor & Co., electrical engineers, of 57, Moorfields, Liverpool.

United Electric Car Co., Ltd.—The report of the directors for the year ending June 30th, 1912, states that after paying debenture interest amounting to £2,283, and charging £6,090 for depreciation, the profit for the year is £15,267, to which is added £2,482 brought from last year, making a total of £17,749. Deducting preference dividend for the six months ending December 31st, 1911, £3,000, there remained an available balance of £14,749. The directors recommend payment of the preference dividend less income-tax for the half-year ending June 30th, 1912, £3,000; a dividend of 5 per cent. less income-tax on the ordinary shares for the year ending June 30th, 1912, £7,500; and the carrying forward to next year of the balance of £4,249. In accordance with the articles of association, two directors retire viz., Mr. Richardson and Mr. Boddington, and being eligible offer themselves for re-election. Mr. Kerr, having inadvertently ceased to hold his necessary qualification shares as a director, temporarily disqualified himself. He has since acquired his full number of shares and has been re-elected by the board, and his re-election comes up for confirmation at the meeting.

CITY NOTES.

Yorkshire Electric Power Co.

The directors' report for the past half-year shows that the gross profit on the revenue account for the three corresponding half-yearly periods ending June 30th was 1912, £5,805; 1911, £6,633; 1910, £4,950. The net profit after payment of mortgage interest for the same periods was £3,349, £4,137 and £2,621 respectively. The balance available at June 30th last including £330 brought forward from 1911 was £3,679, and the directors recommend that this amount should be dealt with by paying a dividend (less income-tax) at the rate of 6 per cent. per annum on the cumulative preference shares, amounting to £2,323, and by carrying forward £1,356. The effect of the coal strike in March last was felt severely in the district supplied by the company, but owing to the provision made, supply was fully maintained throughout the strike to all users who rely on the company for their supply of power and light. The reduction in profits is due to the strike, to extra cost of fuel during the continuance of the strike and immediately thereafter when it was necessary to replenish the coal stock, and to the reduced consumption and unsatisfactory conditions of working produced by the disturbance of trade throughout the district. The directors regret to report a breakdown at Thornhill in July last, and gratefully acknowledge the consideration shown by the customers of the company during the short period of reduced supply required to couple up the additional plant which had already been installed at the works. The very considerable additions the company is making to the generating plant will, in the opinion of the directors, not only meet the increase of business, but also provide ample reserve power to secure a certain and continuous supply to customers in the future, even in the event of one or more units being temporarily disabled from any unforeseen cause. A special meeting of proprietors living in Leeds and district was held on July 23rd last, to explain the reasons for the formation of the Yorkshire Waste Heat Co., Ltd., and a report of this meeting will be circulated. It is believed that the generation of electrical energy with waste heat from coke ovens at Barugh will result in considerable economy and assist in the further development of the company's business. The whole of the preference capital (£100,000) authorised in September, 1910, has been applied for, and a quotation of these shares has been obtained on the Leeds Stock Exchange. The rapid development of the company's business and the increasing demands for electrical energy will necessitate a further issue of cumulative preference shares. At the close of the ordinary meeting on September 17th an extraordinary meeting will be held to consider the authorisation of an issue of 10,000 shares of £5 each. The directors regret to report the death of Mr. Hudson, who had been a director of the company since its commencement.

Halifax and Bermudas Cable Co., Ltd.—The twenty-third annual meeting of the above company was held on September 5th at 33, Old Broad Street. The proceedings were private, but our representative was furnished with a copy of the printed report, which states that the net result of the working for the year ended June 30th, 1912, is an available balance of £8,533, as compared with £8,168 for the previous year. An interim dividend of 2½ per cent., free of income-tax, has already been paid, and it is now proposed to make a further equal payment, free of income-tax, which will leave £6,033 to be carried forward. The balance to credit of revenue account, which was last year £27,345, has been debited with £1,250 applied to dividend, and credited with £6,033 surplus revenue of the past year, and it now stands at £32,128. It is proposed to elect to seats at the board Mr. T. Hewitt Skinner and Mr. William M. Kent. Mr. Geo. G. Ward and Mr. Frederick Ward retire on this occasion, and, being eligible, offer themselves for re-election.

British Electric Transformer Co., Ltd.—The directors have declared an interim dividend at the rate of 6 per cent. per annum, less income-tax, on the ordinary shares, for the half-year to June 30th.

Oxford Electric Co., Ltd.—The directors have declared an interim dividend at the rate of 6 per cent. per annum (3s. per share), less income-tax, on the ordinary shares for the half-year to June 30th.

County of Durham Electrical Power Distribution Co.—The directors announce an interim dividend of 2½ per cent. on the preference shares, payable on October 1st, less tax.

Buenos Ayres Port and City Tramways Co.—The directors report for the year ended December 31st, 1911, that the result of the year's working was a profit of £16,256, subject to provision for debenture interest. This required a sum of £23,367, to which had to be added £1,750, the amount of the sinking fund contributions for the year. The net result, therefore, was a debit balance of £8,861. The traffic receipts showed considerable increases, due mainly to the opening of the line from the boundary of the city at Barracas Bridge to the suburb of Alsina; and in the early part of the year there was a satisfactory diminution in the percentage of working expenses. In May, however, very severe floods occurred, materially affecting the working costs and decreasing the receipts; and from that time onwards the ratio of expenses has increased rather than diminished.—*Financial News.*

Dumbarton Burgh and County Tramways.

At the meeting of this company Mr. George Balfour, chairman, in moving the adoption of the annual report, said the result of the year's working was very satisfactory. The total receipts for the year amounted to £22,532, being an increase of traffic receipts of £2,160, which, together with an increase in receipts from advertising, made a total increase of £2,248. Working expenses are only increased by £214, the result being an increase of net revenue for the year of slightly over £2,000. The company's cars ran 534,832 miles during the year and carried 5,133,846 passengers. Regarding depreciation, the directors feel that they have adopted the soundest method of providing for depreciation, viz., by redemption of debenture stock. It was the unanimous opinion of the directors that it would be unwise to make a distribution on the ordinary shares this year, and that it was in the interest of both classes of shareholders that the surplus should be carried forward. The carry forward amounted to £4,568, and this might be regarded as a dividend equalisation fund, and, bearing this in mind, the directors were of opinion that a continuance of approximately the present earnings would justify them in making a distribution on the ordinary shares next year.

The report having been adopted, Mr. Balfour intimated that, in view of his election as chairman of the company, he proposed to waive the benefit of his agreement as managing director. He accordingly moved that the remuneration of the directors (which was voluntarily reduced to £350 by the directors two years ago) should, until otherwise determined, be at the rate of £600 per annum, to be divided among the members of the board as they should themselves resolve. This was unanimously agreed to.

Direct West India Cable Co., Ltd.—The directors state that the net result of the year's working is an available balance of £7,764, as compared with £6,323 for the previous year. An interim dividend of 3 per cent., free of income-tax, has already been paid, and it is now proposed to make a further equal payment, free of income-tax, which will leave £5,964 to be carried forward. The balance to credit of revenue account, which was last year £37,149, has been debited with £900 applied to dividend, and credited with £5,964 surplus revenue of the past year, and it now stands at £42,213. During the year debentures have been paid off to the amount of £7,000, leaving £22,000 outstanding.

Manila Electric Railroad and Lighting Corporation.—The Municipal and General Securities Co., Ltd. (European agents), announce that a dividend of 1½ per cent. ($1.50 per share) for the quarter ending September 30th has been declared on the common capital stock of the above corporation, payable in New York on October 1st to stockholders on record at September 18th, 1912.

STOCKS AND SHARES.

Tuesday Evening.

After their hurry and flurry of the preceding fortnight, Stock Exchange markets have gone rather more quietly, with the usual result that prices are down on balance, and, if such a thing may be mentioned, there is so much the less to write about here. Perhaps the firmest market this past week has been that for Electric Supply shares, while the Latin-Canadian group has been disposed to go back a little, and the Underground Railway stocks are irregular.

Steady crumbling in the price of Consols is of no use to investment markets, but this time it has had a useful effect in checking new issues, of which recently there have been comparatively few, in spite of the unusual activity of markets for this season of the year. The improvements which we noted last month amongst Home Railway Prior Charge stocks are maintained fairly well, although here and there appears some sign of weakening, for buyers are not quite so eager as they were before the Bank Rate went up at the end of last month.

The strength of Electric Supply shares is the more noticeable in that other investment sections are quiet. Various hints have been given here for some time past as to the probability of Electric Lighting shares advancing; and, of course, the record of the past three months bears out the wisdom of those who bought shares for themselves. August was a dry month in the market—in contra-distinction to what it was out-of-doors. But this week the rise has been resumed, and gains have been scored by Brompton Ordinary and Preference, Charing Cross Ordinary, Metropolitans, St. James', and Westminsters. Moreover, it is not an easy matter to secure the leading shares except at prices very near the top of those officially quoted; and although there is a fair amount of floating supply, it does not take much inquiry to make the sellers put up their prices. The only fall in the list is one of 15s. in City of London Ordinary, which are back to 16¾ middle, the speculative account in these being still quite heavy enough for the shares to be affected when general conditions round the Stock Exchange are disposed to dulness. In our modest opinion, Electric Lighting shares should certainly not be sold, for the prospects are that the rise will go yet further.

The Underground Railway group remains the centre of considerable animation and interest. There was a little hesitation shown on the part of holders last week on the

news of the collision on the Piccadilly Tube, but, in the event, this did not bring out much stock. Central London Ordinary and Deferred have slipped back a point. City and South London Ordinary is lower to the same extent. Districts fell ¼, although Underground Electric Railway shares are strong, the Ordinary hardening ¼ and the "A" shares, in which a good deal of business is reviving, improved to 15s. When there is anything doing in these, the market is a lively one; there is a close price, and they are popular gambles with a wide circle of operators. Metropolitan Consolidated, after being flat, hardened up, and shows a rise of 1¼, after its jump of nearly five points last week. Great Northern and City Preferred rose ⅛ to 2⅛, and there has been a lot doing in the stocks of the East London Railway, upon further attention having been called to the prospects of the line under electrification. From 9½ the price rose to 10⅜, reacting later on to 9⅞. The three junior Debenture stocks are all substantially better.

London Tramway shares are merely quiet, and command little attention. Foreign Tractions descriptions are also somewhat inactive. Mexico Trams fell a point, receding to the position they occupied a fortnight ago. The news from Mexico is still a little disquieting, and owing to the difficulty of getting reliable information, the market in Mexican Railway stocks has been weak. Other Mexican things, however, keep their prices fairly well. Mexican Light and Power Common are easier in tone. Vera Cruz Bonds, however, rose 1, and Mexico Trams Sixes put on ½, holders of the Fives evidently exchanging into these, for the price of the former is ½ lower. Rio Trams at 152 show a small loss, and La Plata Trams at 10s. middle are ⅛ down. A private letter from Vancouver speaks of the amazing prosperity of the British Columbia Electric Railway, the writer complaining, indeed, of the way in which the company's cars are literally packed, in spite of the number which it has running. The Deferred stock has risen 2. Para Electric Railways Ordinary shares continue their improvement, and have again jumped $\frac{3}{16}$, while the 6 per cent. Preference shares are ⅛ higher at 5¼.

In the Canadian group, Electric Developments of Ontario Bonds are a point down, while Canadian General Electric Preference came into some notice in consequence of the good yield accorded by the investment, and the price moved up to 123½. Montreal Light and Power has failed to recover any of the 10 points which the price lost last week, and Sao Paulo Trams are steady at their previous quotation. Brazilian Traction shares eased off a little to 97.

Fresh excitement has broken out in the National Telephone market, and the price of the Deferred stock, after being dull at 150, moved up swiftly to 157½. The grounds for this sudden rush were, of course, declared to be the probability of the stock being paid off at a much higher figure; but, as we said before, to deal in the stock is an amusement only for those with good nerves and a sound financial constitution. Marconis, too, have been revived in popular favour, and the prices of all the shares connected with the group have again been advanced. The parent shares at $5\frac{9}{16}$ are now fully £1 over the figure to which they dipped only a fortnight since. There has been an increased demand for the American Marconis and Canadian Marconis, the latter more particularly from the speculative investor, who will not touch Marconis proper because of the relatively high price at which they stand, but who likes to have an interest in this comparatively new industry with such possibilities. West India and Panama Telegraphs are moving erratically, and on balance show a slight fall. The Eastern group is steady, with ⅛ rise in "China" shares, and ½ in Eastern Telegraph stock. The Anglo-American division retains its rises, and in the manufacturing shares there is no special alteration.

India-rubbers are a strong market, and at 11½ are 10s. up on the week. The rise has failed to bring out any of the shares which were bought by shrewd people when the company passed its last dividend, and there are more buyers than sellers at the moment. British Westinghouse 4 per cent. Debenture stock and British Aluminium 5 per cent. Debenture stock are better to the extent of 2 and 1 respectively. In the share list, Castner-Kellners hardened to $3\frac{13}{16}$ upon the expectation of an improved dividend; while Babcocks eased off in consequence of a general weakening in their particular market. Rubber shares have been depressed by a record amount of the raw stuff being brought forward at the auctions in Mincing Lane this week; but those who profess to study the market appear to consider that there may be a recovery when the sales are over. For the time being, the rubber market is slackening its hold upon public fancy, and until rubber itself makes a move towards a higher level, it is possible that shares will be disposed to sag.

MARKET QUOTATIONS.

It should be remembered, in making use of the figures appearing in the following list, that in some cases the prices are only general, and may vary according to quantities and other circumstances.

Wednesday, September 11th.

CHEMICALS, &c.		Latest Price.	Fortnight's Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	..
a „ Nitric	„	22/-	..
a „ Oxalic	per lb.	2¾d.	..
a „ Sulphuric	per cwt.	5/6	..
a Ammoniac Sal	„	42/-	..
a Ammonia, Muriate (large crystal)	per ton	£29 10	..
a Bleaching powder	„	£5 10	..
a Bisulphide of Carbon	„	£18	..
a Borax	„	£16 10	..
a Copper Sulphate	„	£24 15	..
a Lead, Nitrate	„	£26 10	..
a „ White Sugar	„	£25 10	..
a „ Peroxide	„	£32	..
c Methylated Spirit	per gal.	2/6	..
a Potassium, Bichromate, in casks	per lb.	3¾d.	..
a Potash, Caustic (88/90 %)	per ton	£22 10	..
a „ Chlorate	per lb.	3¾d.	..
a „ Perchlorate	„	4½d.	..
a Potassium, Cyanide (98/100 %) (for mining purposes only)	„	7½d.	..
a Shellac	per cwt.	70/-	..
a Sulphate of Magnesia	per ton	£4 10	..
a Sulphur, Sublimed Flowers	„	£6 10	..
a „ Recovered	„	£5 10	..
a „ Lump	„	£5 5	..
a Soda, Caustic (white 70/72 %)	„	£10 5	..
a „ Chlorate	per lb.	3¾d.	..
a „ Crystals	per ton	£3 5	..
a Sodium Bichromate, casks	per lb	3d.	..
METALS, &c.			
b Aluminium Ingots, in ton lots	per ton	£80	..
b „ Wire, in ton lots	„	£102	..
b „ Sheet, in ton lots	„	£120	..
p Babbitt's metal ingots	„	£98 to £145	..
c Brass (rolled metal 2" to 12" basis)	per lb.	9¼d.	1d. inc.
c „ Tube (brazed)	„	11⅜d.	¼d. inc.
c „ „ (solid drawn)	„	10d.	¼d. inc.
c „ Wire, basis	„	9¼d.	⅜d. inc.
c Copper Tubes (brazed)	„	1/0⅜d.	¼d. inc.
c „ „ (solid drawn)	„	11⅜d.	¼d. inc.
g „ Bars (best selected)	per ton	£95	..
g „ Sheet	„	£95	..
g „ Rod	„	£95	..
d „ (Electrolytic) Bars	„	£82 10s.	10s. inc.
d „ „ Sheets	„	£100 10s.	10s. inc.
d „ „ Rods	„	£89	10s. inc.
d „ „ H.C. Wire	per lb.	10½d.	½d. inc.
f Ebonite Rod	„	5/3	..
f „ Sheet	„	4/9	..
n German Silver Wire	„	1/7	..
h Gutta-percha, fine	„	..	..
h India-rubber, Para fine	„	4/10	3½d. dec.
i Iron Pig (Cleveland warrants)	per ton	66/10½	8/1½ inc.
l „ Wire, galv. No. 8, P.O. qual.	„	£14	..
g Lead, English Pig	„	£23 10	£2 inc.
m Manganin Wire No. 28	per lb.	6/6	..
g Mercury	per bot.	£8 5	10s. inc.
c Mica (in original cases) small	per lb.	6d. to 3s.	..
c „ „ „ medium	„	3/6 to 6/-	..
c „ „ „ large	„	7/6 to 11/-	..
p Phosphor Bronze, plain castings	„	11d.	..
p „ „ rolled bars & rods	„	1/0½	..
p „ „ rolled strip & sheet	„	1/1	..
o Platinum	per oz.	185/-	..
d Silicium Bronze Wire	per lb.	11d.	..
Steel, Magnet, in bars	per ton	£55	..
g Tin, Block (English)	„	£225	£10 inc.
n „ Wire, Nos. 1 to 16	per lb.	2/6	2d. inc.
p White Anti-friction Metals	per ton	£45 to £150	..
k Zinc, Sh't (Vieille Montagne bnd.)	„	£30 12 6	7/6 inc.

Quotations supplied by—

a G. Boor & Co.
b The British Aluminium Co., Ltd.
c Thos. Bolton & Sons, Ltd.
d Frederick Smith & Co.
e F. Wiggins & Sons.
f India-Rubber, Gutta-Percha and Telegraph Works Co., Ltd.
g James & Shakspeare.
h E Iward Till & Co.
i Bolling & Lowe.
k Morris Ashby, Ltd.
l Richard Johnson & Nephew, Ltd.
m W. T. Glover & Co., Ltd.
n P. Ormiston & Sons
o Johnson, Matthey & Co., Ltd
p
r W. F. Dennis & Co.

Stock Exchange Notices.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to:—

Callender's Share and Investment Trust, Ltd.—£115,000 5 per cent. debenture stock.

And to allow the following securities to be quoted in the Official List:—

Melbourne Electric Supply Co., Ltd.—Further issue of £125,880 consolidated ordinary stock.

Rio de Janeiro Tramway, Light and Power Co., Ltd.—Certificates of deposit for shares of $100 fully paid.

Sao Paulo Tramway, Light and Power Co., Ltd.—Certificates of deposit for shares of $100 each fully paid.

Globe Telegraph and Trust Co.—The directors announce an interim dividend of 2s. per share on the ordinary shares for the past quarter.

South Metropolitan Electric Light and Power Co., Ltd.—The directors have declared the usual dividends on the 7 per cent. first preference shares and 6 per cent. second preference shares for the half-year to June 30th. The debenture stock register and register of transfers will be closed from September 17th to 30th, 1912 (both days inclusive), for the preparation of warrants for interest for the half-year to October 1st.

Continental.—La Société "Oriona" is the name of a new company which has just been formed in Brussels with a capital of £40,000 to manufacture metal-filament electric lamps.

The Suddeutsche Telefon-Apparate, Kabel und Drahtwerke Gesellschaft is the name of a new company which has just been formed in Nuremberg with a capital of £50,000 to acquire and carry on the Nuremberg branch of the business of Messrs. Felten und Guilleaume Carlswerk, of Mulheim.

SHARE LIST OF ELECTRICAL COMPANIES.

ENGLISH ELECTRICITY SUPPLY AND POWER COMPANIES.

NAME.	Stock or Share.	Dividends for 1910.	Dividends for 1911.	Closing Quotations Sept. 10th.	Rise + or Fall —	Present Yield p.c. £ s. d.
Bournemouth & Poole, Ord.	10	5½	5½	9⅞ — 10⅛	..	5 2 4
Do. 4½ % Pref.	10	4½	4½	8⅞ — 9⅛	..	4 12 4
Do. Second 6 % Pref.	10	6	6	10½ — 10¾	..	5 11 7
Do. 4½ % Deb. Stock	Stock	4½	4½	98 —100	..	4 10 0
Brompton & Kensington, Ord.	5	10	10†	8⅝ — 9⅛	+ ⅛	5 9 7
Do. 7 % Cum. Pref.	5	7	7	7⅞ — 8¼	+ ⅛	4 4 10
Central Electric Supply, 4 % Guar. Deb.	100	4	4	97 —100	..	4 0 0
Charing Cross, West End & City	5	5	5	4⅞ — 5⅛	+ ⅛	4 15 3
Do. 4½ % Cum. Pref.	5	4½	4½	4½ — 4⅝	..	4 17 4
Do. "City Undertaking" 4½ % Cum. Pref.	5	4½	4½	8⅜ — 4½	..	5 6 0
Do. Do. 4 % Deb.	100	4	4	94 — 96	..	4 3 4
Chelsea, Ord.	5	5	5	4½ — 5	..	5 0 0
Do. 4½ % Deb.	Stock	4½	4½	98 —101	..	4 9 1
City of London, Ord.	10	7	8	16 — 17¼	— ¼	4 11 5
Do. 6 % Cum. Pref.	10	6	6	12 — 13⅛	..	4 9 0
Do. 5 % Deb.	Stock	5	5	118 —122	..	4 2 0
Do. 4½ % Second Deb.	100	4½	4½	99 —102	..	4 8 3
County of London, Ord.	10	5	6	11⅜ — 11⅞	..	5 1 1
Do. 6 % Pref.	10	6	6	11⅝ — 12⅛	..	4 17 0
Do. 4½ % Deb.	Stock	4½	4½	106 —108	..	4 3 4
Do. 4½ % Second Deb.	Stock	4½	4½	100 —103	..	4 8 3
Edmundson's, Ord.	5	Nil	Nil	7/16 — 11/16	..	Nil
Do. 6 % Cum. Pref.	5	Nil	Nil	3— 3⅛	..	Nil
Do. 4½ % First Mort. Deb.	100	4½	4½	84 — 87	..	5 3 6
Folkestone	5	6	6	4⅜ — 5⅛	..	5 14 3
Do. 5 % Cum. Pref.	5	5	5	4⅜ — 5¼	..	4 15 3
Do. 4½ % First Deb.	100	4½	4½	92 — 95	..	4 14 9
Hove	5	9	9	7⅞ — 8	..	5 12 6
Kensington & Knightsbridge, Ord	5	9	9	7¼ — 7⅝	..	5 16 2
Do. 4 % Deb.	Stock	4	4	90 — 93	..	4 6 0
Kent Elec. Power, 4½ % Deb.	Stock	4½	4½	78 — 82	..	5 9 9
London Electric, Ord.	8	2	2½	1⅜ — 1⅞	..	4 0 8
Do. 6 % Pref.	5	6	6	4⅜ — 5⅛xd	..	5 14 3
Do. 4 % First Mort. Deb.	Stock	4	4	90 —93	..	4 6 0
Metropolitan	5	5	4	3⅜ — 4	+ ⅛	5 0 0
Do. 4½ % Cum. Pref.	5	4½	4½	4⅛ — 4⅜	..	4 17 4
Do. 4½ % First Mort. Deb.	Stock	4½	4½	99 —102	..	4 8 3
Do. 3½ % Mort. Deb.	Stock	3½	3½	86 — 88	..	3 19 7
Midland Electric Corporation 4½ % First Mort. Deb.	100	4½	4½	97⅞ — 99½	..	4 10 6
Newcastle-on-Tyne 5 % Pref., Non-Cum.	5	5	5	4⅜ — 4⅞	..	5 2
North Metropolitan Power Supply, 5 % Mortgages (Red.)	100	5	5	101 —104	..	4 16 2
Notting Hill, 6 % Non-Cum. Pref.	10	..	6	10 — 11	..	5 9 1
Oxford	5	7½	7½	5⅞ — 6⅜	..	5 13 9
St. James' and Pall Mall, Ord.	5	10	10	8¾ — 9⅛	+ ⅛	5 5 3
Do. 7 % Pref.	5	7	7	6⅞ — 7⅛	..	4 16 7
Do. 3½ % Deb.	100	3½	3½	83 — 86	..	4 1 5
Smithfield Markets, Ord.	5	Nil	2	1⅜ — 1⅝	..	..
South London, Ord.	4	5	5	3 — 3½	..	5 14 3
Do. 5 % First Mort. Deb.	100	5	5	98 —101	..	4 19 0
South Metropolitan, 7 % Pref.	1	7	7	1⅛ — 1⅜	..	5 12 0
Do. 4½ % First Deb. Stock	100	4½	4½	97 —100	..	4 10 0
Urban, Ord.	£3	5	..	2/16 — 3/16	..	..
Do. 5 % Cum. Pref.	5	5	2	2⅛ — 3	..	..
Do. 4½ % First Mort. Deb.	100	4½	4½	80⅜ — 83⅜	..	5 1 8
Westminster, Ord.	5	10	10	8⅞ — 9⅛	+ ⅛	5 8 1
Do. 4½ % Cum. Pref.	5	4½	4½	5 — 5⅜	..	4 3 0

COLONIAL AND FOREIGN ELECTRICITY SUPPLY AND POWER.

Adelaide, 6 % Pref.	5	6	6	5⅞ — 5¾xd	..	5 4 4
Calcutta, Ord.	5	8½	8½	7⅞ — 8	..	5 6 3
Do. 5 % Pref.	5	5	5	4 15/16 — 5 1/16 xd	..	4 16 5
Calgary Power, 1st Mort. Bds.	100	5	5	95⅜ — 97½	..	5 2 7
Canadian Gen. El. Com.	$100	7	7†	114 —119	..	5 17 8
Do. 7 % Pref.	$100	7	7	121 —125	+1	5 12 0
Cordoba Lt., Power and T., Ord.	1	3	3†	1 3/16 — 1 5/16	..	3 4 0
Do. 5 % Deb.	100	5	..	95 — 98	+1	5 2 0
Elec. Lt. and P. of Cochabamba, 6 % Bonds	100	6	6	92 — 94	..	6 7 8
Elec. Supply Victoria, 5 % 1st Mort. Deb.	100	5	5	81 — 84	..	5 19 1
Elec. Dev. Ontario, 5 % 1st Mort. Bonds	$500	5	5	96 —98 xd	—1	5 2 0
Kalgoorlie Elec. P. and L., Ord.	10/-	Nil	..	1/16 — 3/16	..	Nil
Do. 6 % Pref.	1	6	6	1/16 — 2/16	..	8 6 0
Kaministiquia Power, 5 % G. Bs.	$500	5	5	104 —106	..	4 14 4
Madras, Ord.	5	..	..	1⅛ — 2⅜	..	..
Melbourne, 5 % 1st Mort. Deb.	100	5	5	102 —105	..	4 15 8
Mexican El. Lt., 5 % 1st M. Bds.	..	5	5	89 — 91	..	5 10 0
Mexican Lt. & Power, Common	$100	4	4	96 — 99	..	4 0 10
Do. 7 % Cum. Pref.	$100	7	7	109 —112	..	6 5 0
Do. 5 % 1st Mort. Gold Bds.	..	5	5	96½ — 98½	..	5 1 6
Monterey Rly. Light & Power, 5 % 1st Mort. Deb.	100	5	5	87 — 89	— ½	5 12 4
Montreal, Lt., H. and Power	$100	7	8	232 —237	..	3 7 6
Northern, Lt., Power and Coal, 5 % 1st Mort. Bonds	$500	5	5	39 — 42	..	..
River Plate, Ord.	Stock	10	10	240 —250	..	4 0 0
Do. 6 % Non-Cum. Pref.	Do.	6	6	109 —114	..	5 5 3
Do. 5 % Deb. Stock	Do.	5	5	101 —103	..	4 17 1
Roy. Elec. Co., Montreal, 4½ % 1st Mort. Deb.	100	4½	4½	99 —101	..	4 9 1
Shawinigan Water, Capital	$100	4	5†	151 —156	..	3 4 1
Do. 5 % Con. 1st Mort. Bonds	$500	5	5	107½—109½	..	4 11 4
Do. 4½ % Per. Deb.	Stock	4½	4½	104 —106	..	4 5 0
Toronto Power, 4½ % Deb.	Do.	4½	4½	99½—101½	..	4 8 8
Vera Cruz Lt., P. and T., 5 % 1st Mort. Deb.	100	5	5	93 — 95	+1	5 5 3
Victoria Falls Power, Pref.	1	Nil	11¾d.	31/32 — 1 1/32	..	..
West Kootenay Power and Lt., 1st Mort. 6 % Gold	100	6	6	103 —105 xd	..	5 14

TELEGRAPH AND TELEPHONE COMPANIES.

Amazon Telegraph	10	Nil	4†	7⅛ — 7⅜	..	5 3 3
Do. 5 % Deb. Red.	Stock	5	5	95½ — 97½	..	5 2 7
American Telep. & Teleg., Cap.	$100	8	8†	147½—149½	..	5 7 0
Do. Collat. Trust	$1000	4	4	93¾ — 95¾	..	4 3 9
Anglo-American Telegraph	Stock	3⅜	3	67½ — 69½	..	5 7 11
Do. 6 % Pref.	Do.	6	6	113 —114½	..	5 5 0
Do. Def.	Do.	80/-	80/-	26⅜ — 26⅝	..	5 12 8
Anglo-Portuguese Tel., 5 % Mort. Deb.	100	5	5	102 —104 xd	..	4 16 2
Chili Telephone	5	7	..	7⅛ — 7⅜	..	4 10 4
Commercial Cable, Stlg. 4% Deb.	Stock	4	4	83⅞ — 85⅞	..	4 13 7
Cuba Telegraph	10	6	6†	9½ — 10⅛	..	5 14 3
Do. 10 % Pref.	10	10	10	16½ — 17½	..	5 14 3
Direct Spanish Telegraph, Ord.	5	4	4†	3⅛ — 3⅜	..	5 6 8
Do. 10 % Cum. Pref.	5	10	10	7 — 7½	..	6 9 0
Direct United States Cable	10	4½	5	7⅛ — 8	..	6 5 0
Direct W. India Cable, 4½ % Reg. Deb.	100	4½	4½	98 —100	..	4 10 0
Eastern Telegraph, Ord. Stock	Stock	7	7	129½—132½	+ ½	5 5 8
Do. 8½ % Pref. Stock	Do.	8½	8½	73 — 80	..	4 7 6
Do. 4 % Mort. Deb.	Do.	4	4	99½—101½	..	3 18 10
Eastern Extension	10	7	7	18⅛ — 18⅜	+ ⅛	5 2 9
Do. 4 % Deb.	Stock	4	4	98½—100½	..	3 19 7
East and S. Africa Tel. 4 % Mt. Db. Mauritius Sub.	25	4	4	97½—100½	..	3 19 7
Globe Telegraph and Trust	10	5⅞	6†	11 — 11½	..	5 4 4
Do. 6 % Pref.	10	6	6	12⅜ — 13½	..	4 10 7
Great Northern Telegraph	10	18	18	28½ — 29½	..	6 3 1
Indo-European Telegraph	25	18	18	57 — 59	..	6 3 5
Mackay Companies Common	$100	5	5	90 — 94	..	5 6 5
Do. 4 % Cum. Pref.	$100	4	4	70 — 73	..	5 9 7
Marconi's Wireless Telegraph	1	5	20	5⅛ — 5⅝	+7/16	3 11 2
Do. 7 % Cum. Partic. Pref.	1	16	17	4⅜ — 5	+ ⅛	3 8 0
Monte Video Telephone, Ord.	1	6	6	1 1/16 — 1 3/16	..	5 6 3
Do. 5 % Pref.	1	5	5	1 3/16 — 1 5/16	..	5 6 8
National Telephone Def.	Stock	6	6	156⅜—158⅜	+¼	..
New York Telep., 4½ % Gen. Bnds.	100	4½	4½	100⅜—101⅜	..	4 8 8
Oriental Telep. and Elec.	1	8	8	1 11/16 — 1 13/16	..	4 8 2
Do. 6 % Cum. Pref.	1	6	6	1 5/16 — 1 3/8	..	4 18 5
Do. 4 % Red. Deb.	Stock	4	4	88 — 90	..	4 9 0
Pacific and European Tel., 4 % Guar. Debs.	Do.	4	4	98 —100	..	3 18 5
Reuter's	8	5	5†	10¼ — 10⅝	..	3 15 9
Submarine Cables Trust	Cert.	6	6	127 —130	..	4 12 4
Telephone Co. of Egypt, 4½ % Deb. Red.	Stock	4½	4½	99½—101½	..	4 8 8
United River Plate Telephone	5	8	8	7½ — 7¾	..	5 6 8
Do. 5 % Cum. Pref.	5	5	5	5⅜ — 5⅝	+ ⅛	4 8 11
West Coast of America	2½	2½	2½	1 1/32 — 1 1/16	..	3 18 5
Do. 4 % Debs., 1 to 1,500 guar. by Bras. Sub. Tel.	100	4	4	96 — 99	..	4 0 10
West India and Panama Teleg.	10	1¼	½	3⅜ — 3⅝	— 1/16	..
Do. 6 % Cum. 1st Pref.	10	6	6	10⅜ — 10⅝	..	5 11 7
Do. 6 % Cum. 2nd Pref.	10	6	6	9⅜ — 10⅜	..	5 17 0
Do. 5 % Debs.	100	5	5	100⅛—102⅛	..	4 17 7
Western Telegraph, Ltd.	10	7	7	13 — 13⅜	..	5 3 8
Do. 4 % Deb.	Stock	4	4	97 — 99	..	4 0 10
Western Union 4½ % Fdg. Bonds	$1000	4½	4½	100 —103	..	4 7 5

* Unless otherwise stated, all shares are fully paid. † Interim dividend.

Continued on next page.

SHARE LIST OF ELECTRICAL COMPANIES.—(*Continued.*)

ELECTRIC RAILWAYS AND TRAMWAYS.—HOME.

NAME.	Stock or Share.	Dividends for 1910.	Dividends for 1911.	Closing Quotations Sept. 10th.	Rise + or Fall —	Present Yield p.c.
	*					£ s. d.
Bath Trams, Pref. Ord.	1	Nil	Nil	—	..	Nil
Do. 5 % Pref.	1	5	5	—	..	6 3 1
Do. 4½ % Deb.	100	4½	4½	78 — 83	..	5 8 5
Brit. Elec. Trac., 6 % Pref.	100	..	..	11 — 13	..	..
Do. Do. Deferred	100	..	..	6 — 8	..	..
Do. Do. 6 % Cum. Pr'f.	100	..	6	89 — 92	..	6 10 5
Do. 7 % Non-Cum. Pr'f.	100	..	..	37 — 40	..	..
Do. 5 % Perp. Deb.	100	5	5	98 —101	..	4 19 0
Do. 4½ % 2nd Deb.	100	4½	4½	80 — 84	..	5 7 2
Central London Railway, Ord.	100	3	3	76 — 78	—1	3 16 11
Do. Pref.	100	4	4	82 — 84	..	4 15 3
Do. Def.	100	2	2	76 — 78	—1	2 11 3
Do. 4 % Deb.	100	4	4	100 —102	+1	3 18 5
City & South London, Ord.	100	1½	1½	37½ — 38½	—1	3 11 5
Do. 5 % Pref., 1891	100	5	5	106 —108	..	4 12 7
Do. Do. 1896	100	5	5	103 —105	..	4 15 3
Do. Do. 1901	100	5	5	103 —105	..	4 15 3
Do. Do. 1903	100	5	5	102 —104	..	4 16 2
Do. 4 % Deb.	100	4	4	99 —101	..	3 19 3
Dublin United Trams, 6 % Pref.	10	6	6	10½ — 11½	..	5 2 2
Great Northern & City, Pr'f. Ord	10	Nil	..	2 — 2¼	+ ⅛	Nil
Hastings Trams, 6 % Pref.	1	Nil	6	—	..	8 0 0
Do. 4½ % Deb.	100	4½	4½	71 — 76	..	5 18 5
Isle of Thanet Trams, 5 % Pref.	5	2½	2½	2¼ — 2⅜	..	4 11 0
Do. 4 % Deb.	100	4	4	75 — 80	..	5 0 0
Lancashire United, 5 % Deb.	100	5	5	81 — 83	..	6 0 6
London Elec. Railw'ys, 4 % Deb.	100	4	4	95 — 97	..	4 2 6
London United Trams, 5 % Pref.	10	Nil	..	4½ — 5¼	..	..
Do. 4 % Deb.	100	4	4	72 — 76	..	5 5 3
Metropolitan Railway Consol.	100	1⅜	1½	60¾ — 61½	+1½	2 18 0
Do. Surplus Lands	100	2⅜	2½	64 — 66	..	4 3 4
Do. 3½ % Deb.	100	3½	3½	87 — 89	..	3 16 11
Do. 3½ % Pref.	100	3½	3½	85 — 87	..	4 0 6
Do. 3½ % Con. Pref.	100	3½	3½	84 — 86	..	4 1 5
Metropolitan District Ord.	100	Nil	Nil	41⅜ — 42	— ¼	Nil
Do. 6 % Deb.	100	6	6	141 —143	..	4 4 0
Do. 4 % Deb.	100	4	4	94 — 96	..	4 3 4
Do. 4 % Prior Lien	100	4	4	99 —101	..	3 19 3
Do. 4½ % First Pref.	100	3½	4½	89 — 91	..	4 19 0
Do. 3½ % Gtd.	100	3½	3½	75 — 77	..	4 11 0
Metropolitan Elec. Trams, Ord.	1	5½	6	1 — 1⅛	..	5 6 8
Do. Def.	1	Nil	..	—	..	Nil
Do. 5 % Pref.	1	5	5	—	..	5 6 8
Do. 4½ % Deb.	100	4½	4½	96 — 98	..	4 11 10
Do. 5 % Deb.	100	5	5	100 —103	+1	4 17 1
Potteries, Ord.	1	2	..	—	..	..
Do. 5 % Pref.	1	5	5	—	..	6 19 0
Do. 4½ % Deb.	100	4½	4½	87 — 90	..	5 0 0
South Metro. Trams, 6 % Pref.	1	6	..	1 — 1⅛	..	7 7 8
Do. 4 % Deb.	100	4	4	70 — 75	..	5 6 8
Underground Elec. Railways	10	..	..	4⅛ — 4½	+ ¼	Nil
Do. "A"	1/-	..	..	—	+ 1/16	..
Do. 4½ % Bonds	100	4½	4½	99 —101	..	4 9 1
Do. 6 % Income	100	1	1½†	89 — 91	..	..
Yorkshire (West Riding), Ord.	5	Nil	..	—	..	Nil
Do. 6 % Pref.	5	Nil	3	2⅜ — 3	..	4 9 0
Do. 4½ % Deb.	100	4½	4½	79 — 83	..	5 8 5

ELECTRICAL RAILWAYS AND TRAMWAYS.—COLONIAL AND FOREIGN.

Anglo-Arg. Trams, 1st Pref.	5	5	5½	5⅝ — 5¾	..	5 2 4
Do. 2nd Pref.	5	5	5½	4⅝ — 5⅞	..	5 6 0
Do. 4 % Deb.	100	4	4	93¼ — 95	..	4 4 3
Do. 4½ % Deb.	100	4½	4½	100 —102	..	4 8 3
Do. 5 % Deb.	100	5	5	101 —103	..	4 17 1
Auckland Trams, 5 % Deb.	100	5	5	103 —105	..	4 15 3
Bombay Elec. S. & Trams, Pref.	10	6	6	11¼ — 12	..	5 0 0
Do. 4½ % Deb.	100	4½	4½	97 — 99	..	4 10 11
Do. 5 % 2nd Deb.	100	5	5	97 — 99	..	5 1 0
Brisbane Trams Invs., Ord.	5	8	8	7 — 7½	..	5 6 8
Do. 5 % Pref.	5	5	5	4⅞ — 5½	..	4 15 8
Do. 4½ % Deb.	100	4½	4½	100½ —103½	..	4 7 0
B. Columbia Elec. Rly., Def.	100	8	8	143 —148	+2	5 8 1
Do. Pref. Ord.	100	6	6	119 —124	..	4 16 9
Do. 5 % Pref.	100	5	5	109 —112	..	4 9 1
Do. 4½ % 1st Mort. Deb.	40	4½	4½	99½ —102½	..	4 7 10
Do. 4½ % Vancouver Deb.	100	4½	4½	103 —105	..	4 5 9
Do. 4½ % Con. Deb.	100	4½	4½	103 —105	+1	4 5 9
Calcutta Trams, Ord.	5	6	7	6⅜ — 6⅝	..	5 5 8
Do. 5 % Pref.	5	5	5	4⅞ — 5⅛	..	4 16 5
Do. 4½ % Deb.	100	4½	4½	99 —102	..	4 8 3
Cape Electric Trams	1	Nil	2½†	—	..	..
City Buenos Aires Trams (1904)	5	5	5	5⅛ — 5⅜	..	4 6 11
Do. 4 % Deb.	100	5	5	99 —102	..	4 18 0
Colombo Elec. Tr. & Lt., 5 % Deb.	100	5	5	95 — 99	..	5 1 0
Havana Elec. Rly., 5 % Bonds	$1000	5	5	99 —103	..	4 17 1
Kalgoorlie Elec. Trams	1	Nil	..	—	..	Nil
Do. 5 % A Deb.	100	5	5	86 — 91	..	5 10 0
Do. 6 % B Deb.	100	5	3	35 — 43	..	6 19 6
La Plata Elec. Trms, Ord.	1	..	..	—	— ⅛	..
Do. Pref.	1	6	6	— 1	..	6 0 0
Lisbon Elec. Trams, Ord.	1	5½	6	1 — 1¼	..	4 8 0
Do. 6 % Pref.	1	6	6	1 — 1¼	..	4 16 0
Do. 5 % Deb.	100	5	5	93 — 97	..	5 3 1
Madras Elec. Tr. (1904), Deb.	100	5	5	100 —102	..	4 18 0
Manaos Trams & Lt., 1st Deb.	100	5	5	90 — 93	..	5 7 6
Manila Elec. R. and Ltg., Bonds	$1000	5	5	100½ —102½	..	4 17 7
Mexico Trams Com.	$100	7	7	127 —130	—1	5 7 8
Do. Gen. Con. 5 % Bonds	..	5	5	99 —101	— ⅛	4 19 0
Do. 6 % Bonds	100	6	6	103 —105	+ ⅛	5 14 3
Para Elec. Rlys. & Lt., Ord.	5	10	10	7½ — 7⅝	+ 1/16	6 7 0
Do. 6 % Pref.	5	6	6	5 — 5⅛	+ ⅛	5 9 1
Do. 5 % 1st Deb.	100	5	5	100½ —102½	..	4 17 6
Perth (W.A.) Elec. Tr., Ord.	1	2½	..	1 3/32 — 1 5/32 xd	..	1 18 4
Do. 5 % 1st. Deb.	100	5	5	99 —102	..	4 18 0
Rangoon El. Tr. & Sup., Pref.	5	6	6	5½ — 5⅝	..	5 4 4
Do. 4½ % 1st Deb.	100	4½	4½	97 — 99	..	4 11 0
Rio de Janeiro Trams	$100	4½	5†	151 —153	—1	3 5 4
Do. 1st Mort. 5 % Bonds	..	5	5	103 —104	..	4 16 2
Do. 5 % Mort. Bonds	100	5	5	100½ —101½	+ ½	4 18 6
Sao Paulo Tram, Lt. and P.	$100	10	10†	261 —266	..	3 15 2
Do. 5 % 1st Deb.	$500	5	5	104½ —106½	..	4 14 0
Singapore Trams, 5 % Deb.	100	5	5	84 — 87	..	5 15 0
Southern El. Tr. B.A., 5 % Deb.	100	5	5	96 — 98	..	5 2 0
Un. Elec. Trams Monte Video	5	6	7	5⅝ — 6⅛	..	5 14 3
Do. 6 % Pref.	5	6	6	4½ — 5⅝	..	5 11 7
Do. 5 % 1st Deb.	100	5	5	101 —104	..	4 16 2
Winnipeg Elec. Rly., 4½ % Deb.	100	4½	4½	104 —106	..	4 4 11

MANUFACTURING COMPANIES.

Aron, Ord.	1	Nil	6	—	..	8 0 0
Do. 6 % Pref.	1	9	6	1⅛ — 1¼	..	7 7 8
Babcock & Wilcox	1	26	28	31/32 — 1 1/32	—1/16	4 4 7
Do. Pref.	1	6	6	1 1/16 — 1 1/16	..	3 16 10
British Aluminium, Ord.	1	..	..	1/32 — 1/16	..	..
Do. 6 % Cum. Pref.	1	..	..	—	..	..
Do. 5 % Prior Lien Debs.	100	5	5	93 — 96	..	5 4 2
Do. Deb. Stk.	100	5	5	85 — 88	+1	5 13 8
B.I. & Helsby Cables	5	10	10	7⅞ — 8¼	..	6 1 3
Do. Pref.	5	6	6	5⅞ — 6⅛	..	4 14 1
Do. Deb.	100	4½	4½	102 —104	+ ½	4 6 7
British Thomson-Houston, Deb.	100	4½	4½	94 — 96 xd	..	4 13 9
British Westinghouse, Pref.	8	Nil	..	—	..	Nil
Do. Deb.	100	4	4	60 — 63	+2	6 7 0
Do. 6 % Prior Lien	100	6	6	102 —105	..	5 14 3
Browett, Lindley, Ord.	1	Nil	..	2/- —3/-	..	Nil
Do. Pref.	1	Nil	..	4/6 —5/-	..	Nil
Brush, 7 % Pref.	2	Nil	..	0 — ½	..	Nil
Do. 5 % Prior Lien Deb.	100	5	5	75 — 80	..	6 5 0
Do. 4½ % Deb.	100	4½	4½	50 — 55 xd	..	8 3 8
Do. 4½ % Second Deb.	100	4½	4½	35 — 40	..	11 5 0
Callender's Cable	5	15	10†	10¾ — 11	..	6 16 4
Do. Pref.	5	5	5	4⅞ — 5⅛	..	4 17 7
Do. Deb.	100	4½	4½	99 —101	..	4 9 1
Castner-Kellner	1	17½	20	8⅜ — 8⅝	+ 1/16	5 3 3
Do. Deb.	100	4½	4½	102 —105	..	4 5 9
Crompton & Co.	8	Nil	Nil	—	..	Nil
Do. Deb.	100	5	5	56 — 66	..	7 11 6
Dick, Kerr	1	5	5	¾ — ⅞	..	5 14 3
Do. Pref.	1	6	6	1 — 1⅛	..	5 6 8
Do. Deb.	100	4½	4½	97 —100	..	4 10 0
Edison & Swan, A, £8 paid	5	Nil	..	1/16 — 1/8	..	Nil
Do. fully paid	5	Nil	..	1/8 — 2⅛	..	Nil
Do. 4 % Deb.	100	4	4	64 — 68	..	5 17 8
Do. 5 % Second Deb.	100	5	5	74 — 77	—1	6 9 10
Electric Construction	2	2½	3¾	¾ — 1	..	7 10 0
Do. Pref.	2	7	7	1⅝ — 2	..	7 0 0
Greenwood & Batley, Pref.	10	7	7	7½ — 8	..	8 5 8
Do. Deb.	100	5	5	92 — 94	..	5 4 2
General Electric, Pref.	10	5	5	10 — 11	..	4 10 11
Do. Deb.	100	4	4	92 — 97	..	4 2 6
Henley's, Ord.	5	15	10†	12 — 12¾	..	5 17 8
Do. Pref.	5	4½	4½	4⅜ — 5	..	4 10 0
Do. Deb.	100	4½	4½	102 —104	..	4 6 7
India-Rubber, G. & T.	10	10	..	11 — 12	+ ½	..
Do. Pref.	10	5	5	9½ — 10½	..	4 17 7
Telegraph Construction	12	20	10†	33½ — 35⅝	..	6 8 2
Do. Deb.	100	4	4	97 — 99	..	4 0 10
Willans & Robinson	1	Nil	..	—	..	Nil
Do. Pref.	5	Nil	..	—	..	Nil
Do. Deb.	100	4	4	58 — 60	..	6 13 4

* Unless otherwise stated, all shares are fully paid. † Interim dividend.

Bank rate of Discount 4 per cent., August 29th, 1912.

THE CARE OF COOLING TOWERS.

[COMMUNICATED.]

A good many central stations are situated in positions where there is no abundant supply of cheap water available, and in order to make it possible for the engines to run condensing, the expedient has been resorted to, in a good many cases, of using cooling towers in connection with the condensing water, the latter being circulated through the condensers and towers repeatedly. In this way undoubted economies are obtained, the amount of water required being limited to the feed for the boilers (this can be minimised if the condensed water can be cleansed of oil and returned to the hot well) and the circulating water for the condenser cooling system. The amount of this latter varies considerably, depending on local conditions and also on the state of humidity of the atmosphere. During dry and hot weather a lot of the circulating water passes away in steam, escaping from the cooling tower, and this has to be made up.

Without a certain amount of care, however, cooling towers may become a nuisance; and without entering at all into the question of design of such cooling towers, it may be permissible to give one or two brief notes concerning the essentially practical points which have to be remembered if a cooling tower, or cooling tower-system, is to be maintained in its proper condition. Some of these towers are built of wood, others of structural steel and mild steel plate. The writer is not prepared to offer any opinion as to which is the best type, as he considers that this is influenced by the conditions under which the tower is to work. For example, a wooden cooling tower is cheap to construct and erect where the necessary raw material in the shape of suitable wood is obtainable, and where labour is fairly cheap. It will, however, be found that the wood is preferably impregnated with some rot-resisting solution, as the failure of one of the principal members of the structure owing to rot may cause the collapse of the whole arrangement. Moreover, the wooden tower is, perhaps, more useful in situations where it is continuously kept in action. If its service is to be intermittent it will be found that the alternating periods of wetness and dryness have a tendency to produce warping, and cracks will soon form in the outer casing diminishing the efficiency, and the woodwork within the structure will probably get distorted. Moreover, as has been shown by more than one sad experience, the wooden tower, when in a dry condition, is liable to catch fire, and this fire may quite easily extend to the other apparatus of the equipment. On the other hand, it must be remembered that a mild steel construction is extremely liable to rust, especially as, in the case of a cooling tower, it is exposed to hot, wet vapour and fine streams of running water. More especially at the seams and rivet holes there is danger of bad rusting setting in, and particularly where the tower is subjected to intermittent work, because there are not only alternating periods of wetness and dryness, but also corresponding periods of heat and cold, causing expansion and contraction among the members of the structure, and slight displacements at the seams. For this reason a mild steel tower should be frequently laid off for a thorough painting inside and out, and about the best preservative which the writer knows for this purpose is good tar. In getting at the inside of the tower it is not sufficient simply to paint over those portions which can be easily seen. Bit by bit the woodwork inside the tower must be removed to make way for the painter, and every square inch of the inside surface must be properly covered when it is in a dry state. It is a tedious and bothersome business, but without it no steel tower is safe.

Another thing which should be very carefully watched in connection with the working of a steel tower is to see that the distribution of the water at the top of the tower is uniform. The makers of different types of towers have each their own device for spreading the water over the top horizontal surface of the tower, so that the water descends through the tower in the form of fine streams or films. On its way down it is frequently caught by baffles and redistributed, so as to keep it well spread over the entire section of the tower. As originally set up, the distributing system may answer perfectly, but many causes operate against continued satisfactory working, unless the tower is watched. For instance, in the course of time, the woodwork inside the tower may take a slightly different bedding, due to the swelling or warping of some of the members, and this may slightly throw the distributing arrangements at the top of the tower out of the horizontal. In those forms of towers whose distribution depends on V notches in the top troughs, the slightest want of truth will cause an undue bulk of water to flow down in one part of the tower as compared with the other. These must be checked by observation, and it should be said that very careful watching is necessary to make sure of the even distribution of the water.

It is not a very pleasant job to stand in the top enclosure of a cooling tower when it is in full action, and, by the light of a portable lamp, try to see through the clouds of water vapour the general distribution of the falling streams. Nevertheless, it has to be done if the cooling tower is to work properly. Then, again, there is the question of floating impurities in the water. After passing through the tower, the water usually falls into an open tank below the tower, from which it is again drawn through the condenser system by the circulating pump of the engine. If this tank is at all exposed, a lot of impure matter gets into it, this matter being of charmingly interesting variety, and some of it gets drawn through the circulating system and pumped up to the top of the tower. As the water loses its velocity in the top distributing system, there is a fine chance for some matter in suspension to settle at the top of the tower, and ultimately choke up one or more of the distributing ducts. This defect is aggravated if, as frequently occurs, the condensed water of the engine is discharged in the condensing system. This is often done because a lot of oil passes through and the station engineer does not think it safe to return the water to the hotwell. The presence of this oil, which is in the form of a soapy scum, makes the distribution at the top of the tower rather difficult unless care is taken to see that the troughs or other distributing devices are carefully and systematically cleaned out at short intervals.

Another point which has to be watched is the appearance of the streams of water falling from the bottom of the tower. The baffles in the tower, which are in nearly every case of wood are arranged by the makers, so that they preserve a uniform distribution of the water, but in course of time portions of these baffles may get displaced owing to the action of the water, or they have been improperly fixed, or the spaces between them may get clogged up with impurities. These causes produce an uneven distribution of the water as it falls to the bottom of the tower, and since the cooling action depends on every portion of the water meeting a maximum amount of upward air, it is obvious that any trouble in the interior of the tower must be watched for and corrected. Fortunately, such troubles do not often occur, as they are among the most difficult to put right. If, for example, one of the baffles half way up the tower in the centre gets displaced, there is a very strong temptation to leave it on account of the difficulty of getting at it.

Some cooling towers depend for their action on natural draught, that is to say, the heat inside the tower produces an upward draught of cold air, which, entering in the space between the tank and the tower itself, passes up the interior of the tower and is discharged at the top usually through an extension piece in the shape of a chimney. Other towers depend on forced draught. In this case, the tower is completely enclosed and the air is driven through it by means of a fan usually electrically driven. The rate of cooling and hence the temperature of the water as it passes into the tank can be regulated by means of the air passed up the tower by the fan, and in this respect the electric motor lends itself very favourably to regulation of speed whereby the tower can, if necessary, be made to cope with overloads for a greater or lesser period. Even so simple a thing as an electric fan, however, requires periodic attention, and cases have been known where the continuous running of a fan has been presumed upon, with the result that the fan has unexpectedly broken down, due either to moisture getting at the motor or to inattention and consequent wear on the bearings. Needless to say, this sort of thing ought not to happen, and would not happen if operating engineers did not forget that their duties of inspection sometimes extended beyond the four walls of the buildings.

The treatment of the tanks themselves is a matter of some importance, particularly where there is an open space between the tower and the tank into which dust may blow, and refuse may be thrown. In course of time an accumulation of foreign matter ranging from mud to disused cats accumulates in these tanks. The collecting pipe for the circulation pumps is usually protected by means of a grid or strum which is calculated to stop any such matter from getting into the circulating system, but the choice lies between making the mesh of the strum large enough to allow the water to pass freely even when a sediment is accumulated, and thus incurring the danger of foreign matter getting through, or making the holes so fine that they may become choked up. In one case a somewhat serious interference with the supply was only narrowly averted. The engines were running on peak load when one of them suddenly lost its vacuum and dropped load, which was thrown on to the other generators, heavily overloading them. Fortunately there was a small spare set which was quickly run up and put into commission to carry the station over the peak, the faulty large engine in the meantime running on atmosphere. Subsequent examination showed the condenser to be very hot, and it was found that the carpenters in erecting the cooling tower had unfortunately let a considerable amount of shavings get into the tanks underneath, and these had not been properly cleaned out before the tank was filled, and this particular system started. When the shavings became sodden with water, as the wood was rather heavy, they sank and accumulated around the strum, with the result that the water could not be drawn from the tank to the condenser, a rush of water only tending to bind the shavings more tightly on to the strum.

In another instance the trouble was even more serious. Some difficulty had apparently been experienced in getting water through to the condenser, and instead of searching out the root cause, the circulating pump—which was an electrically driven one of the centrifugal type—was simply speeded up until the suction on the tank was, perhaps, twice its proper value. The result was that the strum suddenly collapsed, and a mass of *débris* consisting of mud, small billets of wood and other obstacles rushed through the pump into the condenser. Some of these billets got wedged in the tube and did an immense amount of damage, and it required a considerable amount of trouble to get them out again. The effect of such an inrush on a reciprocating pump could easily be imagined. If the pump had rubber valves, the rubber would be torn away and the metal guards would be bent into useless shapes, while even with metal valves the damage would very likely be very considerable. Therefore it is obvious that careful attention should be paid to the periodic cleaning out of these tanks. Where it is impossible to put the cooling tower system altogether out of commission, as is the case in a good many large stations, the load should be taken if possible on other cooling towers. Each tower should have a separate tank with an equalising pipe passing between and valves whereby each tank can be isolated. Similarly, it is advantageous not to draw direct from the tank, but to place on the outlet a subsidiary tank of moderate capacity from which the supply of each circulating system is drawn. This subsidiary tank should be capable of being shut off from the main tank by means of a valve, and all the subsidiary tanks should be joined together by means of an equalising pipe with valves, the return arm, forming a ring main, being utilised for the suction of the circulating systems.

When the water is delivered to the top of the cooling towers, it should be delivered first of all to a similar ring main system from which each tower can be fed as required. In this way it is possible to do two or three things. It the first place, each tower with its tank can be shut off from the rest without interfering with the circulating system normally connected to it; next the subsidiary tanks act as a species of buffer between the tanks themselves and the circulating system; the load on the engines can be distributed as desired among the various cooling towers; the tanks can be run dry or kept at various levels as desired; and when a test on any particular engine is required, one tower can be separated off to deal with the circulating system of that engine without interfering in any way with the running of the main station. With such an arrangement the cleaning out of the towers can be accomplished with the greatest ease, the tanks being pumped dry and the load taken up by the other towers. Where there is no duplicate tower and tanks, of course, the only thing to do is to cut off the make-up water, if this is supplied, until the level of the water in the tank has been reduced as much as is safely possible and then to put the tower out of commission, running the remaining water in the tank away to waste and cleaning out the tank. This is, as will be seen, a rather wasteful process. In some installations the evil day is deferred as long as possible by using some form of strum having self-cleaning arrangements operating by reversal of flow, change of position, or some other device, but the only satisfactory method in the long run is to go straight to the root of the trouble and keep the tanks clean.

Most of the above remarks when set down in writing appear to be self-evident, as it really only requires a little care and common sense to look after a cooling tower equipment. The fact remains, however, that troubles have occurred which might have been prevented, and this is, therefore, the apology for offering a reminder that even a cooling tower sometimes requires a little attention on the part of those who have the responsibility for the proper maintenance of the plant.

WEAR OF TRAMCAR WHEELS.

The question of the wear of wheels on electrical street railway rolling stock is a very important one, inasmuch as the amount of wear very largely determines an important proportion of the maintenance expenses of a tramway undertaking, and therefore a note concerning a difficulty which was discovered on one undertaking may not be without interest. It was noted in this case that the wear in the wheels of some single truck cars was very unequal, and at first it was thought that the wheels, as supplied to the undertaking, were of very unequal quality and durability. Investigation, however, showed that the fault did not lie with the wheels themselves, but with the trucks on which

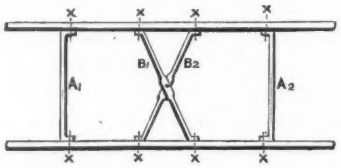


Fig. 1.

they were mounted. It was discovered that the cross braces of the truck frames were not sufficiently rigid, and that the trucks themselves were out of alignment.

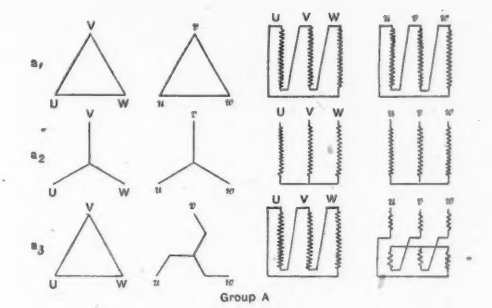
Fig. 1 shows diagrammatically the bracing of the trucks, in which A^1 A^2 are the cross braces, B^1 B^2 being the diagonal braces. In the construction ordinary black iron bolts had been used on the braces, and trouble had been experienced owing to these bolts slacking and working in the holes. It was appreciated that it was at this point where lack of rigidity occurred, and therefore the truck frames were lined up afresh, and the braces were then fitted with turned taper bolts, which were made a tight driving fit in tapered holes in the frames, the taper being secured by rehammering out the original bolt holes. In this way a beautiful fit was obtained in the holes, which were formerly rather slack, and no further trouble was experienced from unequal wearing of the wheels.

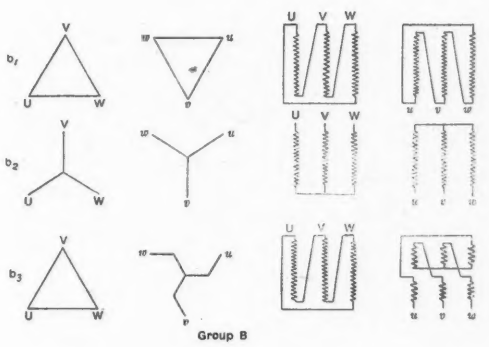
This incident goes to show the extreme care which is necessary in the construction of tramway trucks in order to secure perfect rigidity and solidity, and any detail, however apparently slight and unimportant, which is overlooked, will give severe results in undue wear and deterioration.

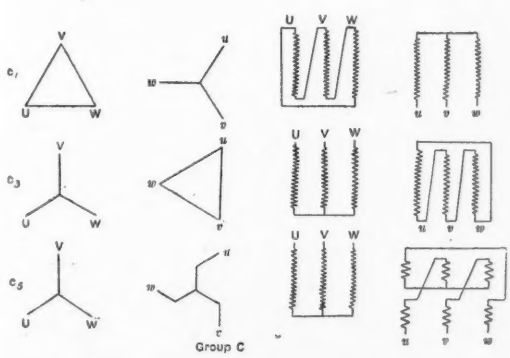
GERMAN RULES FOR TESTING AND RATING ELECTRICAL MACHINERY AND TRANSFORMERS.

THE "Maschinennormalien" Committee of the V.D.E. has lately issued a revised set of rules for the rating and testing of electrical machinery and transformers, and the more important quantitative recommendations are reproduced in abstract in the following paragraphs. The new rules are very clear and reasonable, but, in view of space limitations, we omit a considerable amount of general matter, which, however necessary in an official set of rules, is familiar to every qualified engineer.

Name-Plates.—Must be stamped with the following particulars, or as many thereof as are applicable to any particular case: Purpose of apparatus; manufacturer's serial number; normal voltage, current and power factor; normal output and working period (*vide infra*); R.P.M.; frequency; starting voltage; excitation voltage. In the case of transformers, the voltage ratio and short-circuit voltage must be quoted and the connecting system must be indicated by the reference letter of the appropriate set of diagrams shown on







the standard charts reproduced herewith. Transformers belonging to the same group may be paralleled by connecting similarly named terminals. In machines or transformers with variable speed or voltage, the corresponding limits of output, voltage, current and R.P.M. must be shown on the name-plate.

Working Period.—Apparatus may be designed for continuous operation without exceeding prescribed temperature limits; or it may be designed to run intermittently for a period which must be marked on the name-plate, and during which the prescribed temperature rise is not exceeded. Short-period ratings may be for 10, 40, 60 or 90 minutes; absence of specified period assumes continuous running.

Commutation.—In machines with stationary brush-gear, commutation must be practically sparkless between quarter and full load (without interpoles), or between light and 25 per cent. overload (with interpoles).

Temperature Rise.—The general conditions and methods advanced for the determination of temperature rise show no novel features. In determining the atmospheric temperature, a number of thermometer readings should be taken during the last quarter of the test, at about half the height of the machine or transformer, and about 1 m. distant from the latter. Where artificial cooling is provided, the temperature of the ingoing air is to be taken. The temperature rise of stationary windings had best be determined by the increase in their ohmic resistance; in other cases, thermometric measurements should be made (as far as possible at the warmest points), and, in designing apparatus, reasonable provision should be made for the introduction of thermometers to various parts.

Assuming an atmospheric temperature of 35° C. (or lower), permissible temperature rises are as follows:—

	General.	*Traction.*
Cotton insulation	50° C.	70° C.
Cotton in oil; slot insulation, including paper	60° C.	80° C.
Enamel, mica, asbestos and compounds thereof	80° C.	100° C.
Commutators	55° C.	80° C.
Slip-rings	60° C.	80° C.
Bearings	50° C.	50° C.

The figures for traction motors are not to be exceeded during one hour's full-load run on the test bed. In stationary D.C. field coils the above allowances may be increased about 10° C. The temperature rise of iron surrounding insulated windings is limited by the insulation. In complex cases the lowest rise determined by any of the above considerations is to be observed.

Overload.—Provided the above temperature regulations are observed, suitable overload capacities are 25 per cent. for half an hour (at normal P.F.), and 40 per cent. for 3 minutes (at normal voltage in the case of motors). Constant-speed machines should be able to run at 15 per cent. above normal R.P.M. without injury for 5 minutes on light load. At normal speed and power factor generators should maintain full terminal voltage up to 15 per cent. overload.

Insulation.—Machines or transformers must withstand the following test pressures, applied as below:—

Normal voltage, 40 — 5,000 volts; test pressure = 2·5 × normal; minimum, 1,000 volts.

Normal voltage, 5,000 — 7,500 volts; test pressure = normal + 7,500; minimum, 12,500 volts.

Normal voltage over 7,500 volts; test pressure = 2·0 × normal; minimum, 15,000 volts.

These rules do not apply to testing transformers for very high pressures. Apparatus for use below 40 volts should be tested at 100 volts. If D.C. is used for testing, all the above pressures must be increased by 40 per cent.

Breakdown tests must be carried out when the apparatus is at its maximum temperature; pressure must be applied gradually and maintained at full value for at least 1 minute. All apparatus should withstand 30 per cent. increase in the working voltage for at least 5 minutes.

Testing pressure is to be applied between the windings and the frame, and between the windings themselves. If windings are for different pressures, the latter test must be at the pressure determined by the higher working voltage. The test pressure between connected windings and frame is to be that determined by the highest working voltage in any part of the circuit.

Separately excited field coils should be tested at 3 × excitation pressure (minimum 1,000 volts); and wound rotors should be tested at 2·5 × the maximum rotor voltage (minimum 100 volts). Cage rotors need not be subjected to breakdown test.

Voltage Regulation.—The voltage regulation of a separately excited generator is the percentage voltage variation which occurs when the load is removed at a moment when the machine is supplying full load at normal voltage. The R.P.M. and excitation are supposed to remain constant; if the speed rises, a correction factor must be applied. In the case of self-excited and compound generators, the same definition applies under the proviso that the position of the field regulator also remains constant during the load variation. Unless otherwise specified, the regulation of an A.C. generator on inductive load is to be taken at 0·8 power factor. In the case of transformers, the ohmic voltage drop should be determined and also the short-circuit voltage at normal current (both referred to secondary).

Appendix.—The following are recommended as desirable values for general adoption:—

Frequency:—50 cycles per second.

A.C. Machines and D.C. Motors.—No. of poles 2, 4, 6, 8, 10, 12, 16, 20, 24, 28, 32, 36, 40, 48, 56, 64, 72, 80; R.P.M. = 6,000 ÷ No. of poles.

Voltage.—D.C. motors 110, 220, 440, 500, 750 volts; A.C. motors and transformer primaries 120, 220, 380, 500, 1,000, 2,000, 3,000 5,000, 6,000 volts.

The direct linear distances between bare live parts and earth, or between those of different polarities or phase, should be not less than the following values:—

Voltage.	*Min. clearance.*
750	30 mm.
3,000	75 mm.
6,000	100 mm.
12,000	125 mm.
24,000	180 mm.
35,000	240 mm.

REVIEWS.

The Electrical Nature of Matter and Radio-activity. By Prof. H. C. Jones. London: Constable & Co., Ltd. Second edition. Price 8s. net.

The contents of this book have already been published as a series of articles in the *Electrical Review*, New York. We are told in the preface that the two correlated subjects under consideration are of such general interest that it seemed desirable that the discussion of them should be made accessible in compact form. The aim of the writer has, therefore, been to present the more important facts and conclusions as far as possible in non-mathematical language. This has been done with the belief that there are a large number of those who have a truly scientific interest in these most recent and important developments in physics and physical chemistry, but to whom a more technical and rigidly mathematical treatment might not appeal. While the work is written in a semi-popular style, the attempt has been made to treat the subject with scientific accuracy. The facts presented have nearly always been taken directly from the original sources.

The author has been extremely successful in his labours. For the man whose mathematical attainments are limited, and whose knowledge of physics and chemistry is but general, the book is the very best that has ever been presented. The whole development of this fascinating subject is treated clearly and consecutively, yet so simply, that one might well wonder how the author could reduce such a recondite matter to such simple terms. Yet this is not a book that treats the subject in an elementary manner. On the contrary, the details are very fully given, and nothing has been omitted of any importance. It is quite a treat to obtain such a readable and interesting account as is here presented.

Chapter I treats of the electrical conductivity of gases, and of the ratio e/m. It shows in simple yet sufficient language how this ratio is obtained for different gases, and how it varies for the different ions of electrolytes.

Chapter II is concerned with the determination of the mass of the negative ion in gases, and reviews the work of Prof. Sir J. J. Thomson in this respect. It shows that the nature of the positive ion is different for every gas, being simply the atom minus that constituent common to all atoms, the corpuscle.

Chapter III is on the nature of the corpuscle and the electrical theory of matter. The experiments of Kaufmann are reviewed. It is shown that the corpuscle is nothing but a disembodied electrical charge, and that the atom of one elementary substance differs from the atom of another only in the number and arrangement of the corpuscles (*i.e.*, the electrons) contained in it.

Chapter IV discusses the nature of the atom in terms of the electron theory. The connection between the latter and the periodic system is shown. Sir J. J. Thomson's partial solution as to the arrangement of the corpuscles that will produce stable systems, in the case of a number of the less complex atoms, is gone into very clearly and without mathematical entanglement, and the beautiful development with regard to univalent, bivalent, trivalent, positive and negative elements, &c., is clearly explained.

Chapter V is on X-rays. It is shown that the X-ray is not a succession of waves in the ether, like light, but is a series of pulses sent out at irregular intervals. The difference between the X-ray and the Becquerel ray is pointed out.

Chapter VI gives an account of the discovery of radium, its spectrum and atomic weight.

Chapter VII discusses other radio-active substances in pitch-blende, such as polonium and actinium, and gives a summary of the types of rays, α, β, γ and δ, emitted by radio-active elements.

Chapter VIII gives a very full treatment of the alpha rays. An account of the spinthariscope is given, with particulars of the theories entertained with regard to it. The chapter discusses the critical velocity of the alpha particles, production of delta particles by the alpha particles, the connection between alpha particles and helium atoms, the action of alpha particles on a photographic and on a fluorescent plate, and the stopping power of matter for the alpha particles.

Chapter IX treats of the beta and gamma rays. It indicates the nature of the charge carried by the beta particle, the determination of e/m for the particle, and shows that it is essentially identical with the cathode particle, only differing in velocity. An estimation of the total number of particles shot off by radium is made.

Chapter X is on various properties of the radiation: the self-luminosity of radium compounds, phosphorescence produced by radium salts, increase in the conductivity of dielectrics by radium, chemical effects produced by radio-active substances, physiological action of the radiations from radium, &c.

Chapter XI discusses the production of heat by radium salts. It shows how the measurement of the heat liberated has been accomplished, and treats of the source of the heat, its effect on solar heat, and the question of the existence of radium in the sun.

Chapter XII gives an account of the emanation from radio-active substances, and this difficult and confusing subject is treated very well indeed. The amount and nature of the emanation are discussed, as well as its diffusion, determination of its molecular weight, and so on.

Chapter XIII gives an account of the experiments made to show that helium is produced from the emanation.

Chapter XIV is on induced radio-activity, and Chapter XV on the production of radio-active matter.

Chapter XVI gives a summary of the theoretical considerations in connection with radio-activity, and shows the importance of a theory of generalisation.

Chapter XVII indicates the wide distribution of radio-active matter, and discusses the origin of radium.

It will thus be seen that the subject is exhaustively dealt with. The book appears to us to be much the best yet published for a non-specialist, and it should certainly be found in the library of every engineer who desires to keep in touch with modern developments in the line treated.

The Electric Circuit. By V. Karapetoff. London: Hill Publishing Co. Price 8s. 6d. net.

The first edition of this book was issued as a pamphlet of 85 pages; the second edition, which we have before us, is a volume containing 230 pages, and claims to give to advanced students of electrical engineering "the theoretical elements necessary for calculation of the performance of dynamo-electric machinery and of transmission lines."

In view of the italicised statement that the book is *not* intended for a beginner, it is rather surprising that the first three chapters are devoted to the discussion of such elementary topics as temperature coefficients and resistances in series and parallel, and even Kirchoff's laws are not exactly satisfying fare for advanced students. Even when we reach the Promised Land of alternating currents in Chapter IV, it is with slow and painful steps that we proceed to conquer the land. Surely the "advanced" student does not need to be spoon-fed with addition and subtraction of vectors before he is prepared to grasp the idea of the power factor.

The chapter on Inductance and Reactance wears a more satisfying appearance, and we are just beginning to find something worthy of the advanced student's attention when we have thrust upon us two whole chapters on the use of complex quantities. This would surely seem to cast a grave aspersion on the mathematical attainments of young American engineers, for whom the book is undoubtedly written, and we would humbly suggest that a working knowledge of De Moivre's theorem and its associated mathematics should precede and not be included in an advanced study of electrical engineering theory.

The author returns from his mathematical digression and deals with polyphase systems in a very straightforward chapter, and then proceeds to the transformer, calculating its regulation by an approximate and also by a more rigid method.

The induction motor is then treated very thoroughly, as a transformer with a short-circuited secondary free to rotate, to the entire exclusion of the synchronous motor,

which, athough simpler in theory, is not so simple as to warrant its complete neglect even in an advanced text-book.

The rest of the book is devoted to the dielectric circuit, the treatment being strictly analogous to that of the electric circuit. The paragraph on the energy in the electrostatic field is especially good, the analogies being well drawn.

Following a discussion of the inductances and capacities of transmission lines, there is an interesting section on current and voltage resonance, and frequent reference is made to the works of Steinmetz on the subject of electric transients, waves, and impulses.

An appendix and bibliography complete the book. The perusal of such a book as this causes one to doubt very seriously the possibility of successfully treating the theoretical matters connected with electrical engineering in a volume apart from the descriptive and practical side of the work. The inconsistencies that we have noted, and the marked discrepancy existing between the acknowledged aim, and the accomplishment of this book must, perhaps, be attributed rather to its method than its author. In any case we shall doubt the *possibility* of the text-book on the theory of electrical engineering until we see a more successful attempt than this.—P. K.

MR. DOOLEY VISITS A TELEPHONE FACTORY.

"Ye know what a tillyphone is, Hinnessy—the little dingus ye lie to yer woife through when ye want to stay downtown av an avenin'? Yez call it a 'phone,' but 'tillyphone' is the roight name fer ut. It comes from the Grayk wurrd 'tilly,' manin' 'to tell,' an' 'phoney,' meanin' somethin' bogus; so whin ye tell them little fibs to yer woife, ye're usin' it accordin' to Hoyle. If I was a married man, Hinnessy (which, thank the Lorrd, I am not), I wud starrt a movement to raise a monymint to the man that invinted the tillyphone. Wid a tillyphone an' six moiles av capper wire, a man kin lay down the law to his woife in a dignified way, widoubt havin' to go to the ixpense av buying a new rollin' pin aftherwards.

"I was out to Hawthorne last wake, visitin' the Westerrn Aylictric Comp'ny's place, where they make thim things. Man, man, but it's a foine place! Whin ye go in at the gate, ye are shtopped be a felly ye take fer a polaceman, until ye see thot he ain't Oirish. He wants to know who ye are an' what yer business is. I tol' him I wanted to see the place.

"'Have yez a pass'? siz he.

"'Past is it?' siz I. 'Shure, do ye have to exhibit yer family skiliton to get through these worruks?'

"No, no,' siz he, 'Oi don't care about yer past. Oi siz 'pass'—a permission to go through the plant.'

"'No, I ain't,' I siz. 'But, maybe ye could git me wan; I'm perfissor av applied electricity (which I am, Hinnessy, fer don't I turn on me own electhric loights'?)

"So I got me pass an' a guide to show me through the worruks. Wan av the things thot struck me furrst was the big clocks shtanding around iverywhere, so's the help will know whin to stop worruk. They looked loik an orthinary toimepace, except thot they had a big circle around thim, wid numbers on it, an' a handle thot ye tuk an shtabbed at the numbers wid; if yez hit the bull's-eye, ye rung a bell. An' they shure have some marksmin over there, Hinnessy. Wan after another walked up to thim clocks, an' divil a wan missed the bull's-eye.

"Siz I to me guide, 'Phwat do they all crowd in so fast for?'

"'Why,' sid he, 'the 8.30 whistle has blew, an' they want to punch in before the clocks register 8.31. Fer if they're a minnit late, they're fifteen minnites late.'

"'Wud ye moind doin' that on paper fer me?' I asked. 'Me arithmetic ain't as spry as it was some years back.'

"'Shure,' he siz. 'I don't know how it's figgered. Thot ain't my job, but I know thim's the rooles.'

"No it luks to me, Hinnessy, loike they was infringin' on me frind Billy Bryan's copyroight. Thrue, he figgered sixteen to wan instid of fifteen to wan, but the principle's the same, an' afther all, what difference does a figger make, as the ossified man said whin he married the fat lady.

"'An' pwhat kapes track av the night force?' I asked.

"'Why, thim same clocks,' siz he.

"'Thin,' siz I, 'why the devil have they got 'em labeled "Dey Time Registers?"'

"'Ye kin search me,' he siz.

"It's a moighty big force they got over there, Hinnessy—hundreds an' hundreds of gurruls, an' ivery wan chewin'.

"'Phwat are they all atin'? I asked the felly.

"'They ain't atin',' he answered. 'They're only chewin'. Ye see, we don't allow thim to chew the rag durin' wurrkin' hours, so they takes to gum. It takes six gum factories, workin' noight an' day, to supply the T. A. buildin' alone.'

"'It's nice woide aisles ye have here,' I remarked, 'but ain't they afther bein' woider thin necessary? Ye waste space.'

"'Yis,' siz he, 'they're pretty wide now, but they was laid out whin hair was in style. Why, a few months back a man had to go through these aisles sideways an' push his shadow through ahead av 'im, to get past the coiffoors widout takin' home enough av thim on his coat to git him in throuble wid his woife. But the comp'ny cudn't git along widout the girruls. Ye know the fair sex completely outclasses us min whin it comes to conversayshun, so the comp'ny hires thim to learn the baby 'phones to talk. Why a man thryin' to butt into the conversation av our gurrul experts wudn't shtand as much chanct of gettin' a hearin' as an echo at a deaf mutes' convintion.'

"An' there's the Worruks lab'ratory, Hinnessy. Thot's a quare place. The've got all kinds av shtrange infernal machines, aylictrical an' chimical, to help thim in their business, which is to call an all-wise but sometimes onrooly Providence up on the cyarpet an' make it explain itsilf whin some conthraption or ither rafuses to come up to 'spec.' 'Spec.' is short for 'specifications,' which is a sort of a Bible iverywan has to live up to, over there. It's diffrunt from the old wan, though. It cuts out the Prophets intoirely. Still, it makes up fer thot by bein' extry shtrong on Commandments. But, as I was sayin', av all the quare conthraptions yez iver seen, they've got the quarest. Oi don't want to brag, but ye knows yersilf, Hinnessy, I've been in some of the foinest bar-rooms in this conthry, but niver annywheres have I seen a collictiou av glassware to aqual theirn. Why, if a man took a drink of wake tay out av wan av thim twisty bottles they have, it wud take him six wakes to git his legs straightened out agin.

"But, shpakin' av twistin', Hinnessy, did ye iver see an insultin' machine puttin' insults on wires? Well, ye don't want to. It luks loike sivinteen attacks of delirium tremens thryin' to bust up a Maypole dance. If I had to luk at wan of thim machines all day, I'd sign the plidge.

"But don't ye be gettin' the notion in yer head thot machines is all there is over there. They've got a libr'y an' a band an' orchesthry, not to mintion the Men's Club, which kapes the mimbers supplied wid lectures, voddyville an' nickel shows free of charrge.

"An' they've got ball grounds an' tinnis coorts an' sick-likes fer thim as wants to amuse thimselves at noon, an' a rist'rant fer the old-fashioned wans thot wants to ate. An' take it from me, Hinnessy, as the b'ys says now-a-days, it's *some* rist'rant. There's a siction upstairs, where ye ate on pay-day at not less than twinty cints a throw; an' the rist av the wake ye kin ate downstairs on the Open Board, where the ante runs from a penny up to whativer you've got. Things shure are fixed up foine. Ye kin git a piece av pie wid decorayshuns on it for tin cints, an' they aven kape burrds for the eddyfication av the guests. An' mind ye, it ain't none av yer quick-lunch joints. It's genteel. I waited half an hour before I got a bite to ate at all. I made wan bad break, Hinnessy, an't it's ashamed av it I am. I ordered a steak, an' afther a bit the young lady sits down a plate befure me. I looked at it, an' thin I siz to her, 'Beggin' yer pardon, Miss, but it's a dirthy plate ye've brought me.'

"'Dirthy?' siz she. 'It looks clane to me. Where's the dirrt, plaze?'

"I pointed out the spot to her.

"'Why, bless yer soul,' she siz, 'thot ain't dirt. Thot's the steak!'

"An' may ye stroike me dead, Hinnessy, if it wasn't."

"'An' was the steak good?' asked Mr. Hennessy.

"'Sh-sh-sh,' said Mr. Dooley. 'I promised on the worrud of a gintlemin not to divulge any company secrets.'"—*Western Electric News.*

An American Fish Story.—The sale of large quantities of fish by dealers and peddlers in Lafayette, Ind., recently attracted the attention of the fish and game warden of Tippecanoe County, who after investigation, assured himself that no seines or nets were in use in his district. Setting out to ascertain the source of the unusual supply of fish, he discovered two men near an interurban railway bridge, one of whom from time to time indulged in the extraordinary practice of striking his fishing pole against the trolley wire, after which the other would gather in a boatload of the dead and stunned fish which floated to the surface. Investigation showed that an insulated wire ran down the fish pole and dipped into the water under the bridge. The 500-volt contact with the trolley served to electrocute all fish near the wire, killing them outright, it is declared, instead of stunning them as in the case of dynamiting.—*Electrical World.*

The Reduction of Iron Ore.—A recent issue of the *Iron and Coal Trades Review* described some experiments at Herräng, Sweden, in the reduction of iron ore to iron sponge by means of a direct process, which it is pointed out is applicable chiefly to Swedish and Norwegian ores. The ore is first subjected to a magnetic treatment, then mixed with coal, and fed into an inclined rotary furnace through which flame from a producer gas furnace passes, the burnt gas being returned to a regenerator for heating the air supplied for combustion. The product analysed between 97 and 98 per cent. of iron. The important feature of the process appears to be the "estimated" low cost, viz., 53s. per ton as against 62s. for electric smelting, and 66s. by the blast furnace method. The capital expenditure is, however, considerably higher than for electric smelting. The figures refer to Scandinavian conditions.

TRADE STATISTICS OF CHILE.

The following figures, showing the imports of electrical and similar goods into Chile in the year 1911, are taken from the official trade statistics recently issued; details for 1910 are not available (peso = 1s. 6d.):—

	Gas and electricity meters.	Lamps.	Copper wire.	Copper, brass or bronze lamps.	Telephones.	Telegraph apparatus.	Materials for telegraph and telephones.	Boilers.	Mining machinery.	Cranes.	Electrical machinery and apparatus.	Machinery and apparatus for electric lighting.	Industrial machinery.	Motors.	Insulators.
Gt. Britain	14,000	47,000	160,000	98,000	17,000	12,000	39,000	83,000	776,000	170,000	149,000	162,000	3,103,000	2,157,000	18,000
Germany ...	86,000	21,000	1,651,000	203,000	106,000	—	44,000	91,000	2,004 000	196,000	449,000	740,000	1,598,000	512,000	84,000
France ...	—	—	—	23,000	—	—	—	—	—	—	18,000	31,000	70,000	—	—
Belgium ...	—	—	—	—	—	—	7,000	—	241,000	—	4,000	42,000	98,000	53,000	—
Austria ...	—	2,000	—	—	—	—	—	—	—	—	—	—	—	—	—
U.S.A. ...	9,000	—	192,000	24,000	8,000	—	14,000	1,000	756,000	22,000	101,000	125,000	489,000	333,000	9,000
Other countries	5,000	—	96,000	5,000	—	1,000	—	—	206,000	27,000	1,500	1,000	82,000	11,000	1,000
Total, pesos	114,000	70,000	2,099,000	353,000	131,000	13,000	104,000	175,000	3,983,000	715,000	722,500	1,101,000	5,440,000	3,066,000	112,000

THE USE OF NAKED ALUMINIUM WIRE IN ELECTROMAGNETS.

In the course of an article in the *Electrical World*, Mr. H. F. Stratton gives some useful information on this subject. On the basis of the Matthiessen standard, he says, the conductivity of 99 per cent. aluminium is 61 per cent. of that of annealed copper, which possesses the characteristics of copper used in magnet wire. A bare aluminium conductor will therefore be 64 per cent. larger in cross-sectional area than a bare copper conductor of equal conductivity.

Fig. 1 gives a graphic comparison between round copper wire and both round and square aluminium wire of sizes having conductivity equal to the conductivity of the various sizes of copper wire. In general, and approximately, the conductivity of any one size of copper wire is equivalent to the conductivity of round aluminium wire of the next two sizes larger, and to the conductivity of square aluminium wire of the next one size larger, in terms of the B. & S. wire gauge.

Since the aluminium oxide should not be exposed to a potential stress larger than 0·5 volt, this oxide film is, in general, serviceable only between turns and not between layers, and it is necessary to wind on a sheet of some insulating material, such as asbestos paper, between layers. The writer has found, in his experience with aluminium coils, extending from a coil containing perhaps ¼ lb. of aluminium up to a coil containing about 400 lb. of aluminium, that the thickness of the insulating material between layers can be successfully taken as about 10 per cent. of the diameter of the wire.

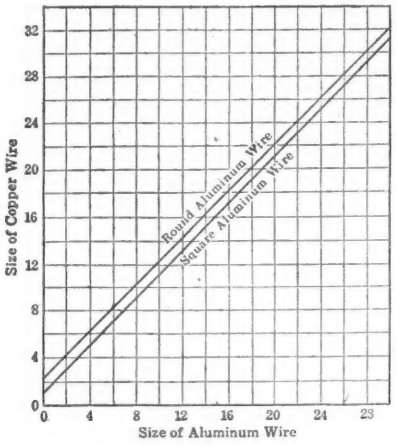


Fig. 1.—Relation of Aluminium and Copper Wires of same Conductivity.

Taking this additional space into consideration, first, comparing single cotton-covered copper wire with round aluminium wire, the space utilisation of the aluminium wire, on a basis of equal conductivity, is unity at No. 29 size of copper wire, less than unity in larger sizes, and greater than unity in smaller sizes; and, secondly, comparing the single cotton-covered copper wire with square aluminium wire, the space utilisation of the aluminium wire, on the basis of equal conductivity, is unity at No. 25 size, less than unity in larger sizes, and greater than unity in smaller sizes.

On the basis of equal conductivity and equal length of conductor it is evident that in most sizes bare aluminium wire will occupy more space than single cotton-covered copper wire, and where the problem is one of replacing a copper coil by an aluminium coil in a fixed coil space in standard apparatus there is evidently small opportunity of accomplishing the desired result if the characteristics of the copper coil must be duplicated by those of the aluminium coil. In many cases it would be pertinent to inquire, however, if a higher ultimate temperature should not be permitted in aluminium coils than in coils constituted of single cotton-covered copper wire. There are undoubtedly many examples of commercial apparatus where the permissible coil temperature is dictated solely by the consideration that this temperature should be kept safely below the charring temperature of the cotton insulation. It has generally been assumed that coils wound with single cotton-covered wire should not reach a higher ultimate temperature than 100° C., and in many cases specifications for lower temperatures are proper and are warranted by considerations of precautions or reductions of the I^2R losses.

On the other hand, the writer is familiar with the history of a large aluminium coil, which, in a lifting magnet, has been subjected almost constantly day and night to a temperature of about 300° C., and which, after quite a long period of operation, as yet shows absolutely no measurable change in resistance. It goes without saying that a coil composed of cotton-covered wire and subjected to these same oparating conditions would by this time have failed completely. It should be noted that the aluminium coil in question, in addition to being subjected to extremely high temperature, also withstood mechanical abuse, the severity of which is probably second to none experienced in electrical apparatus.

Where the increase in resistance due to rise in temperature has determined the final temperature of copper coils, a slightly higher temperature may be permitted with the same results in the case of aluminium coils, since the temperature resistance coefficient of aluminium is about 6 per cent. less than that of soft copper.

When, however, the question of coil weight is considered, the advantage of aluminium over copper is so conspicuous as not to be open to argument. An aluminium coil will weigh about 49 per cent. as much as a copper coil composed of single cotton-covered copper wire and of equal conductivity and length of conductor.

When the very important question of cost is considered, the use of aluminium seems to show some startling advantages. The accompanying table was prepared showing the saving in the cost of conductor secured by using bare aluminium wire in place of single cotton-covered copper wire, and assuming in each case that a size of aluminium wire was employed having a conductivity equal to that of copper wire. This table considers round and square aluminium wire of several typical sizes; it was based on quotations existing in May, 1912, and is, of course, inconsistent in its relative figures pertaining to different sizes of wire, since it takes into account the arbitrary fixing of prices of both aluminium and copper. It should not be assumed that the total cost of aluminium coils should be less than the total costs of copper coils in the ratio indicated by this table, since the winding and other processes of manufacture of aluminium coils will be found to be more expensive than similar operations in the case of copper coils. This table does, however, indicate the possibilities of large monetary savings to the electrical industry, when it is remembered that insulated copper wire to the value of many millions of dollars is used annually in building the various kinds of electrical machinery.

Size of copper wire, B. and S. gauge.	Percentage saved, round aluminium wire.	Percentage saved, square aluminium wire.
0	32	20
5	33	20
10	36	25
15	40	20
20	27	2
25	36	17
30	26	−8

Aluminium wire can be purchased under the supposition that it is enveloped in a skin of aluminium oxide. The writer, however, has not been able to wind coils of such wire which do not exhibit a serious degree of short-circuit, either because the oxide did not sufficiently enclose the wire when it was received from the wire manufacturers, or because the oxide was partly scraped off during the process of winding. In Europe some manufacturers claim to have formed the oxide successfully on the surface of the wire after

the coil has been wound, by thoroughly wetting the entire coil structure with water and then heating the coil. In such a case, the oxide is supposed to be formed by the presence of the hot moisture. The writer, in attempting to carry out this process, succeeded in forming a considerable degree of the oxide, but not enough to prevent a partial short-circuit, and not nearly enough to produce a coil of absolutely stable and uniform resistance. Very successful results have been obtained by passing the wire through a solution of sodium hydroxide as the wire is wound on the coil, and then drying out the solution by passing current through the coil winding. The current, of course, should be regulated by a rheostat, as initially quite a degree of short-circuit will exist, but as the temperature of the coil increases with the progress of the chemical action, and as the moisture is driven off, the resistance of the coil will increase until it reaches a point where no short-circuit exists in the entire coil structure.

Irrespective of the precise chemical composition of the substance which results from the action of sodium hydroxide and metallic aluminium, the fact remains that this substance, in practice, has proved to be stable, and a sufficiently good insulator.

In winding large coils which contain such a length of conductor that joints must be made, it will be found that the aluminium wire can be easily and successfully welded together. The procedure is first to cut off the two ends of the wire squarely, and hold each of them in the flame of a blow-torch until they become molten. The film of aluminium oxide which will surround the coil, being very highly refractory, does not melt, and serves to inclose and retain the molten metal. After the two ends have reached this condition they should be suddenly pushed together, and it will be found that a weld will be secured which will exhibit nearly, if not entirely, 100 per cent. strength and electrical conductivity.

VERTICAL SYNCHRONOUS BOOSTER ROTARIES.

The American Westinghouse Co. has recently completed two vertical-shaft synchronous-booster type commutating-pole rotary converters, each of 3,000-kw. capacity, for the New York Edison Co.'s Clinton and Crosby Street sub-stations.

The converters deliver a normal direct-current voltage of 270 and are for 25-cycle six-phase operation. The direct-current voltage variation obtained by virtue of the booster feature is 15 per cent. buck and 15 per cent. boost from the normal voltage, giving a total direct-current voltage variation of 30 per cent. These machines

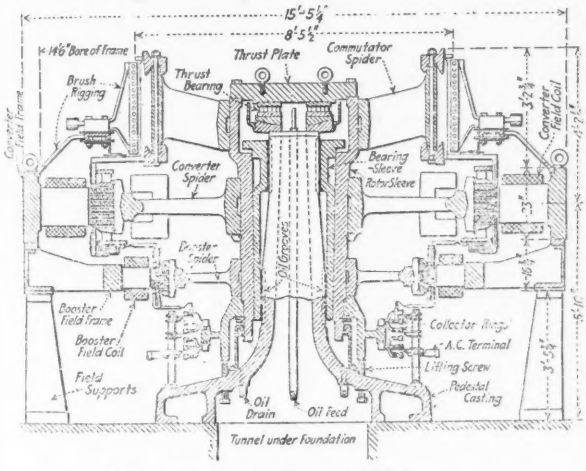


Fig. 1.—Sectional View of Machine.

were made of the vertical type to conform in general construction to the other converters in the sub-stations, all of which are vertical machines.

Fig. 1 shows the detail construction of the machines. The converter armature and frame are mounted above the booster armature and frame. The commutator is at the top of the machine and the collector rings are at the bottom. The armature is of the usual construction mounted on the same shaft with the smaller booster armature, which is connected in series with the converter armature, so that when the booster-field excitation is varied the alternating-current voltage impressed on the converter armature will be decreased or increased accordingly.

The main or converter poles are shunt wound. The commutating poles which lie between the main poles have been so wound that variations in armature reaction introduced by the booster are taken care of. The copper grids embedded in the main pole faces do not extend from pole to pole as in ordinary machines, but are cut off flush with the sides of each main pole. This construction is used on all commutating-pole converters, and forms the most effective starting and damping winding. The booster poles are shunt wound, and the booster field is arranged for hand regulation. Provision is made for effectively cooling the commutator by the insertion of copper heat-radiating vanes in the upper end of each commutator bar. Ample space is provided between the commutator necks, which extend from the commutator bars to the armature coils, and through these spaces the cooling air is forced by the rotation of the machines.

A commutating-pole converter which is to be started from the alternating-current end must be provided with a brush-lifting device, but inasmuch as these machines are to be started from the direct-current end, a brush-lifting arrangement is not necessary.

A roller thrust bearing is arranged at the top of the pedestal to take the weight of the revolving element. The bearing rests on a plate which has a spherical seat carried on the pedestal so that

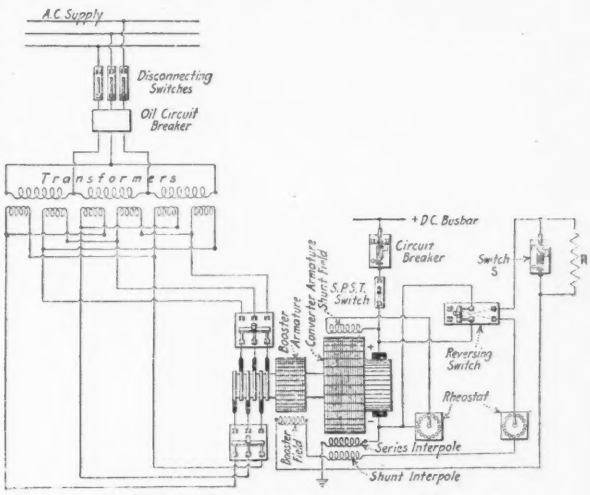


Fig. 2.—Typical Connections of Machine.

alignment is assured. The roller bearing can be taken out by removing the top plate of the machine. To assume the weight of the rotating part at times when it is necessary to remove the top plate, six 1¾-in. bolts are provided in the lower portion of the pedestal flange. When it is necessary to take off the top plate, these bolts are screwed up until they raise the rotating element a trifle and assume its weight.

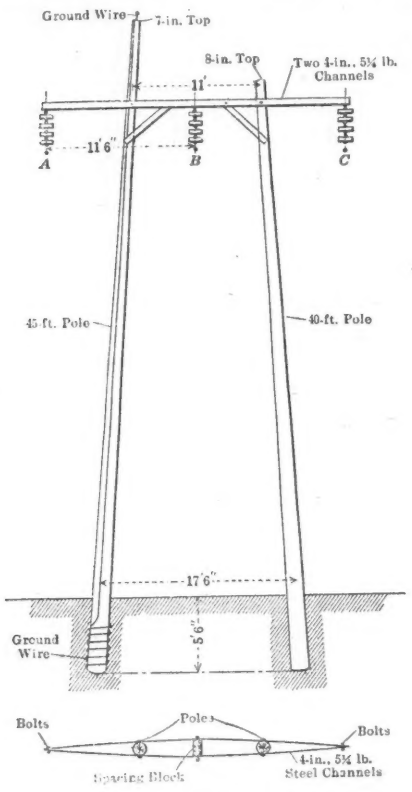
Lubrication is effected with a gravity oiling system. The oil is drawn from the reservoirs and forced up through the oil pipe in the centre of the pedestal. At the top of the pedestal, the oil discharges through a nozzle into a cylindrical chamber within the roller bearing. The pressure on the oil forces it from this chamber out between the bearing rollers into an annular pan surrounding the roller bearing; the height of the outlet nozzle and the oil pan rim are such that the bearing rollers always travel in a bath of oil. When the oil overflows, it passes into an annular chamber just above the upper pedestal bearing and through oil grooves in the pedestal. While it is passing through these grooves, the rotating babbitt bearing surfaces take up oil. From the upper pedestal bearing the oil flows down through the chamber around the shaft to oil grooves for the lower bearing similar to those above described. Fig. 2 shows typical wiring connections for a machine of this class. The switch S is so attached to the circuit-breaker that it closes when the latter is closed, and the resistance R is then short-circuited. Upon opening the circuit-breaker, the resistance is put into the booster field circuit and the shunt interpole windings by the opening of switch S. It is necessary to introduce this resistance in the shunt interpole circuit to prevent the neutral position from shifting when the circuit-breaker trips under load.

A description of these machines appeared in a recent issue of *Power* (U.S.A.), from which journal our illustrations are taken.

WOODEN TOWER FOR 100,000-VOLT TRANSMISSION LINE.

The wooden transmission tower construction shown in the sketch on p. 440 has been adopted by the Central Colorado Power Co. for a new 70-mile line at 100,000 volts. Each tower comprises one 45-ft. and one 40-ft. pole, which are set into the ground to a depth of 5 ft. 6 in. At the ground line the poles are separated by a distance of 17 ft. 6 in., and converge to a distance of 11 ft. at a level 35-ft. above the ground. The cross-arm is formed of a pair of 4-in. 5¼-lb. steel channels bolted together at their ends and enclosing the poles as a bow-spring. Although pinned to the poles by through bolts, the spring pressure of these deflected channels is sufficient to grip the cross-arm securely in position. A 10-in. spacing block is inserted at the mid-point of the bow, and the channels are braced to the poles with 4-ft. knee-pieces. These towers are being spaced at 500-ft. intervals throughout the 70-mile line which is under construction.

The arrangement of suspension insulators used places all three-phase wires in the same plane. While such disposition is susceptible of slight theoretical disadvantages, the arrangement has the great practical advantage of permitting any wire to be reached and worked upon without danger of contact with the others. As the sketch shows, the ground wire is carried at a distance of nearly



Wooden Tower for 100,000-Volt Line.

8 ft. from the nearest conductor. At each pole a ground tap is run down under staples and wrapped in a spiral about the pole butt to provide a permanent earth connection. The Central Colorado Co. has used a construction similar to this in some of its 13,000-volt lines, where the bow-spring cross-arms are formed of two 6-in. × 6-in. hardwood members. With this construction spans as long as 1,100 ft. have been used.—*Electrical World.*

FOREIGN AND COLONIAL TARIFFS ON ELECTRICAL GOODS.

Amendments.

RUSSIA.—British firms exporting goods to Russia are often in doubt and difficulty as to the proper steps to be taken in appealing against the fines and overcharges which are frequently imposed by the Russian Customs authorities, mostly on account of clerical or other errors in bills of lading, invoices and Customs documents. In a memorandum recently issued for the guidance of British firms, the Foreign Office points out that although these fines and overcharges are imposed upon the agents, consignees, or receivers of the goods in Russia, the responsibility falls eventually upon the British merchants or shippers, who should therefore carefully observe the procedure prescribed by the Russian Customs regulations, as well as the rules established for soliciting any possible assistance from His Britannic Majesty's diplomatic and Consular representatives.

When the agents, consignees, or receivers of goods in Russia have unsuccessfully protested at the local Custom house, they have a right during two months to petition direct to the Customs Department at St. Petersburg. To enable them to do this the merchants or shippers in England should furnish them without delay with all necessary information and legalise any documentary evidence by having it sworn to before a competent British authority, whose signature must then be attested by a Russian Consul.

Apart from this, the British merchants or shippers also are at liberty to present a similar petition in English or Russian within the same two months to the same Customs Department, and this petition may be forwarded either direct or through the British Consulate at St. Petersburg, subject, however, to observance of the rules given in the last two paragraphs of this circular.

Should this petition to the Customs Department be rejected, a further two months' period is allowed from the date of the rejection within which to address a petition to the Russian Minister of Finance. The second petition, like the first, may be sent in either direct or through the British Consulate.

At the same time, at this stage of the proceedings the aid may be invoked of His Britannic Majesty's Ambassador, in which case all information and copies and translations of all petitions and documents in the matter must be sent in to the British Embassy at St. Petersburg, with a request for official support; but in no case should the complaint be brought to the notice of the Russian Government in the first instance through the channel of His Majesty's Embassy.

If all these steps fail to obtain satisfaction for the petitioners, the latter may make a final appeal within another two months' period to the governing Senate in St. Petersburg; but as this appeal is a purely judicial matter, the British Embassy and British Consulate cannot be asked to interfere.

No attention is paid to petitions or appeals which reach their destination after the expiration of the two months' limit in each case as above described.

Every application or petition addressed to the Russian authorities must be accompanied by a 75-copeck Russian revenue stamp for each double sheet of foolscap upon which the petition is written, and one 75-copeck revenue stamp for the reply. These stamps may be purchased and affixed to the petition by his Majesty's Consul at the request of the parties concerned. And in each such case the sum of 8s. 3d., if the petition consist of not more than one sheet of foolscap, should be remitted to his Majesty's Consul at St. Petersburg in English penny postage stamps, for defraying the cost of the Russian stamps, and for a Consular fee of 5s., chargeable for sending in a covering dispatch with the petition.

NEW PATENTS APPLIED FOR, 1912.

(NOT YET PUBLISHED.)

ompiled expressly for this journal by Messrs. W. P. Thompson & Co., Electrical Patent Agents, 285, High Holborn, London, W.C., and at Liverpool and Bradford, to whom all inquiries should be addressed.

19,480. "Electric arc lighting systems." M. J. Railing and O. Brooks. August 26th.

19,481. "Method of and means for indicating the continuity and workability of telephonic systems." W. J. Ricketts. August 26th.

19,483. "Electrical generation and transmission of power, for industrial and ships' auxiliary machine-driving, propulsion of ships, road and rail locomotives, tramcars, omnibuses, trains, and other self-contained vehicles, and the like." W. P. Durtnall. August 26th.

19,522. "Magnetic toy and game." H. Brockas. August 26th.

19,533. "Electric fuses." G. W. Christians. (Convention date, December 27th, 1911, United States.) August 26th. (Complete.)

19,534. "Electrical junction boxes." T. E. Murray. (Convention date, September 11th, 1911, United States.) August 26th. (Complete.)

19,535. "Connection apparatus for electric circuit conductors." T. E. Murray. (Convention date, February 9th, 1912, United States.) August 26th. (Complete.)

19,537. "Systems of electric distribution." Compagnie Francaise pour l'Exploitation des Procedes Thomson-Houston. (Convention date, August 26th, 1911, France.) August 26th. (Complete.)

19,538. "Holders for telephone receivers." G. B. Stern. August 26th. (Complete.)

19,543. "Electric cooking and heating apparatus." G. Wilkinson. August 27th.

19,569. "Polyphase electro-motors for marine propulsion." B. Ljungstrom. August 27th.

19,585. "Electric signalling systems." Sir A. T. Dawson and G. T. Buckham. August 27th.

19,587. "Water-tight electric bells." E. A. Graham. August 27th. (Complete.)

19,607. "Furnaces of the channel type." E. C. R. Marks. (Electric Smelting and Aluminium Co., United States.) August 27th. (Complete.)

19,621. "Shade supports for electric or incandescent lights." J. N. Mollett and E. E. Edwards. August 28th.

19,642. "Fuse devices for electric circuits." J. H. Tucker. August 28th.

19,647. "Electric fittings." British Thomson-Houston Co., Ltd. (General Electric Co., United States.) August 28th.

19,661. "Electrical massage apparatus." G. W. Mascord. August 28th.

19,708. "Electric thermometer." R. Alt. August 29th.

19,740. "Contact fingers or brushes for electric controllers and like purposes." W. G. H. Cox. August 29th.

19,754. "Electrically heated cookers." A. J. Kercher. August 29th. (Complete.)

19,763. "Apparatus for producing electric oscillations adapted for wireless communication and other purposes." W. Dubilier. (Addition to 11,091, 1912.) August 29th.

19,771. "Electrically heated cookers." A. J. Kercher. August 29th. (Complete.)

19,787. "Rotary engine with electrical power transmission gear." A. Beldiman. (Convention date, September 26th, 1911, Germany.) August 29th. (Complete.)

19,807. "Electric flexible conducting-cords." M. S. Conner and J. Healey. August 30th.

19,825. "Electrically-propelled road vehicles." E. Cross. August 30th.

19,834. "Telephone meters." G. L. Bates. August 30th.

19,868. "Musical instruments with electrically-operated vibratory sounders." M. L. Severy and G. B. Sinclair. August 30th. (Complete.)

19,869. "Musical instruments with electrically-operated vibratory sounders." M. L. Severy and G. B. Sinclair. August 30th. (Complete.)

19,870. "Pulsation timing devices for use in electrically-operated vibratory musical instruments." M. L. Severy and G. B. Sinclair. August 30th. (Complete.)

19,890. "Electric locomotives, motor-boats, and the like." Maschinenfabrik Oerlikon. (Convention date, September 23rd, 1911, Switzerland.) August 31st. (Complete.)

19,900. "Resonating-relays." H. von Kramer and G. Kapp. (Addition to 5,950/12.) August 31st.

19,913. "Magneto-ignition apparatus." Hartmann & Braun Akt. Ges. (Convention date, August 31st, 1911, Germany.) August 31st. (Complete.)